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BUILDINGS AND MACHINERY

PRIMROSE McCONNELL

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FARM EQUIPMENT
BUILDINGS AND MACHINERY

A PRACTICAL HANDBOOK

BY

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FARMER, NORTH WYCKE, SOUTHMINSTER, ESSEX

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PREFACE

THIS Handbook is the fourth and last of the series comprising "The Complete Farmer," and treats of a branch of the subject to which comparatively little attention has hitherto been given, but on which farmers are now waking up very considerably. The ordinary man is usually well acquainted with his stock and crop and the general management of his farm, but in the matter of machinery, buildings, and general fitments, he is only now learning.

The present generation has undoubtedly seen great progress in these matters compared with the previous ones, but there is room for very great improvement yet. In this volume — which is complete in itself as far as possible —the best and most advanced methods of laying off a farm and its homestead to expedite the working, and of adapting machinery to do the actual work, are discussed; also the probable further improvements we may soon see in force.

It is not possible, within the space at disposal, to touch on everything in this department, but it is hoped that enough prominence has been given to each branch of it to indicate what has already been accomplished, and the lines on which future development should take place.

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FARM EQUIPMENT: BUILDINGS AND MACHINERY

CHAPTER I.—THE HOMESTEAD

A PIECE of land in its natural forest or prairie state is of comparatively little use for farming purposes until much time and money and work have been spent to convert it into a farm. Before we can start to grow crops and put live stock on it, the farm must be supplied with buildings, fences, roads, water, implements, etc. It is, indeed, as necessary to see to these things as to cultivate the soil or to feed the cattle, and while all farms in this country are more or less already equipped, the best methods of improvement are worthy of study. We begin, therefore, with the planning of the Homestead.

It is very seldom that a completely new set of farm buildings can be erected anywhere nowadays, because every farm is already provided with housing accommodation of some sort, however deficient. In the great majority of cases the present buildings exist on sites that have been occupied for generations, and there has been a continual making and remaking in bygone times. Thus in nearly every case a farmer has to put up with an inadequate arrangement of his homestead, which has been got together without any definite plan, or without any idea of saving labour, or of making things convenient and suitable for the housing of live stock, implements and produce.

A further difficulty is that the growth of sanitary science has demonstrated that many of the arrangements regarding air-space, lighting, drainage, disposal of manure, water supply, etc., which were reckoned proper and desirable in the times of our forefathers, are not nowadays permissible, and it is often very difficult, besides being expensive, to alter a steading to suit new ideas. There are certain rules and regulations, however, regarding the designing of

a homestead or farm-town which should always be taken into consideration, either in erecting new buildings, or in altering old ones; for the farm that is equipped with a well-arranged homestead is always more "desirable," and will fetch more rent than one that is badly fitted up.

Different kinds of farms require different kinds of homesteads, and it is not possible to design one which will suit all cases, or which can even be modified to suit every case. It is only possible, therefore, to give a general sketch to illustrate the principles of laying out or improving a steading to suit all the requirements of cheapness, efficiency and saving of labour in the healthy handling and housing of stock and produce.

I.—Site

The first point is that the steading should be as near the centre of the farm as possible, so that all parts may be equally accessible for working purposes. There are many local circumstances which may prevent the occupation of a central position, but it is manifest that a homestead at one end or one corner of a farm adds very much to the inconvenience and expense of working it. Especially is this so in the case of the arable land, where the horses have to travel daily to and from their work, and where the manure has to be carted out and the crops carted home.

The next point regarding the situation is that it should be easily accessible from the public highway. It is not desirable to have the buildings right on the side of the road: there is always the danger of tramps and wastrels getting into them at night—especially on the main roads—while nowadays the dust from motor-cars has to be reckoned with as well as the danger in driving live stock across the road. The width of a field from the highway is a suitable distance, and this does not necessitate too much roadway to be kept up by the farmer.

Again, it is not desirable to set the steading upon the top of a hill or at the bottom of a hollow. More material has to be carted to the buildings, in the shape of crop, than is carted away in manure, and therefore the uphill work should be reduced as much as possible. Again, water must be brought to the buildings, and it should be gravitation water if obtainable; a site on a hill makes this difficult. A site in a hollow is objectionable because of the liability to summer frosts, the difficulty of drainage, and the greater danger to health from a damp, low-lying place.

On the side of a gentle slope facing the sun, from two to three hundred yards from the highway—where the water supply and drainage can be satisfactorily carried out—and as central as possible, is the best site for the homestead.

Of course many other things influence the selection of a situation. In a hilly country, for instance, the obtaining of water is comparatively easy, and as this is a cheap motive-power—either by a turbine or a water wheel—it was and is desirable to put the homestead in such a position that a head of water can be so utilised. There is a limit to this, however, and many old homesteads—or the barns separate from the homesteads—are placed very awkwardly in order to use this power. Nowadays, when we have cheap oil-engines, and the portable thrashing machine is easily obtainable, it would be a mistake to go too far out of the proper course merely to get hold of a mill-dam. Where an old homestead of this sort already exists the occupier must make the best of it, but the better principles should be understood.

In many valleys another circumstance influences the selection of a site. The most central position might be one subject to flooding, and it may be necessary to have the homestead on a knoll or on the higher ground and quite at one end of the farm.

There are thus many circumstances which determine the selection of a site besides mere centrality. It often happens that the land on an estate as a whole is not very wisely allotted to the various homesteads. We meet with farms which have isolated fields at a distance ; of instances where a certain field would much more conveniently be part of the neighbouring farm, and so on. There are sometimes special reasons for these inconveniences, but in nine cases out of ten a redistribution of the fields, so that each farm should have its own lot in one block round the homestead, would be an advantage to everyone concerned.

II.—Materials

There is a wide choice of materials in most districts for erecting a homestead. Timber, timber and iron, brick, and stone prevail in different places, and of late years concrete is being used for many portions of buildings in addition to its adaptation for flooring material. In rocky or bouldery districts stone was invariably used in the olden time, because it was found on the land and only cost the labour of collecting, while clearing the fields at the same time Buildings were then made on a massive scale which no one would

attempt now. In our days creosoted wood and galvanised corrugated sheet-iron have come largely into vogue, and are exceptionally suitable for the purpose because of the cheapness, the quickness of erection, and the ease with which a range of buildings can be altered or adapted. The only objection is the inflammability of creosoted wood: if a fire once starts, the whole range goes up in smoke in a few minutes. This can be overcome partly, however, by creosoting only the parts in the ground and painting the rest with non-inflammable composition or using iron-sheeting instead of weather-boarding for the covering material. In any case the whole outside is better painted, even when of galvanised iron, for it lasts longer. Near the seaside or in a manufacturing district, galvanised iron sheets are soon weathered through if not painted. An oxide paint is the best for preservation. The usual kind of sheets adopted are the gauges known as Nos. 20 and 22, but for heavier and more lasting work No. 18 is better. Each sheet laps three inches over its neighbour and covers two feet in width when laid; the perpendicular lap should be six inches.

Nine-inch brickwork is, perhaps, the best and cheapest of all material for walls, when everything is taken into account. It is easily erected, and easily altered as regards making or closing up openings; it is fireproof, and gives an equable temperature inside at all periods of the year. Its cost is very little more than timber and iron—which must generally have a brickwork foundation at any rate. In many cases, however, timber "quartering," covered by weather-boarding is the most convenient material to use.

Timber used in fencing is best creosoted, for that will be erected outside, away from danger of fire, while it is fencing materials that are most liable to rot. The six inches or so of a stake just below the surface of the ground is where the bacteria causing decay are most active, and if this portion is treated the life of the fence is much lengthened. The best and most convenient method of treatment is to set half barrels as tubs in an isolated shed, fill partly with water and partly with creosote. Into these the butt ends or ground portion of the posts or stakes are put, the creosote floats on the water, and thus the part of the stake which will be just under the surface of the ground is thoroughly soaked in the preservative, and the protective treatment is complete.

Flooring.—Of all the kinds of material yet tried nothing has equalled Portland cement concrete for the flooring of farm buildings. Cobble-stones, flagstones, lime concrete, asphalt, etc., have all had their turn in the olden times, but it is only in our day that we have

got satisfactory flooring. The use of Portland cement concrete is practically compulsory in dairies and cowsheds and other buildings connected with the milk-producing department of a farm, as it is sanitary, easily kept clean, and prevents soakage of sewage downwards. It is also more or less absolutely necessary for loose-boxes, cattle-pens, pig-houses, and the like, while it is the best for barns, granaries, storehouses, mixing-floors, and, indeed, for every kind of building.

The only place where it is not suitable is in the horse stable. There is nothing inherently objectionable in its use for this purpose, for it is hard, smooth, impermeable to moisture, and not slippery, but the difficulty is in laying it. Portland cement concrete takes practically a year to "set," or harden properly, but for ordinary purposes—such as a cowhouse floor, where the traffic is light and the feet of the animals are soft—it may be walked on in a week or ten days after laying. Where cart-horses go with heavy iron-shod feet, damage will be done, and therefore paving-setts must be used (which ought to be grouted with cement, however) to make a lasting and satisfactory floor. If concrete is determined on, the floor must be covered for months with a thick layer of straw or sheeted with boards to protect it from the feet of the horses.

The only drawback to the use of this material is its coldness : it is a good conductor of heat, and therefore animals must be kept well bedded where they lie on a floor of this sort. Milk cows, especially, require their udders to be kept off this kind of floor when lying down.

The usual composition of concrete for flooring—or, indeed, for any other purpose—is one part of cement, two parts of sharp sand, and three parts of gravel, broken stone, clinkers or any hard rubble. The materials must be free from earth or silt, and therefore it is often necessary to wash the sand and gravel before using. It is necessary also to lay a foundation, a few inches thick, of broken material well rammed. A thickness of four inches of concrete on the top of this will make a satisfactory floor for all ordinary purposes, while in special cases this may be faced with a little neat cement.

III.—General Arrangements

Next to a suitable site for the homestead is the arranging of the compartments and divisions of the buildings on the most convenient plan.

1. *Concentration* —In the days of our fathers a favourite idea was to have the whole homestead under one roof, or a series of contiguous roofs—complete concentration, in fact—so that it was possible to

pass from one compartment to another, or from one kind of stock to another, without crossing a yard or going through a door. The objection to this form is the danger of complete destruction in case of fire, while the difficulties of lighting and ventilation are so great that sanitary authorities are inclined to look with disfavour on such, and it is more than likely, if plans of a "concentrated" steading were submitted nowadays to the local authorities, they would refuse to pass them. Another objection is that contiguous roofs (ridge and valley) are very difficult to keep in order, the gutter or valley between having always a tendency to leak.

The idea of concentration is, of course, to have everything as handy as possible, and to economise labour, space, and cost of building. The danger from the drawbacks mentioned is very great, however, and we have now gone back to the older idea of separate ranges of buildings.

On the Continent (Switzerland and Holland, for instance), and in the United States and Canada, the idea of concentrating all the buildings into one huge "barn" is common, and this is generally made about three stories in height, with the lower one partly sunk in the side of a hill. The live stock usually stand on the second floor—accessible from a raised roadway—and the manure drops into the story or "cellar" beneath. The idea in this case is not merely that of concentration and the saving of labour, but such a course is in a measure rendered necessary by the deep snows of winter which would block up yards and roadways such as we have in this country; therefore everything must be put close together and under cover. The lighting and ventilation, however, give trouble, and elaborate arrangements have to be made to meet the case, while a fire is disastrous.

2. *Trident Block Plan.*—The majority of farmers who understand these matters are now agreed that for this country what is called the "trident" principle for the block plan of a homestead is the best: the barn proper with all the food-preparing arrangements should occupy a range of buildings on the north side (running east and west), while the live stock buildings should be placed end on to this (running north and south), with open yards between. By this arrangement the barn range (generally two stories in height in part) acts as a shelter towards the north (or north-east) quarter, while the yards and doors of the other buildings are more or less open to the south, are separate from one another in case of fire, and are at the same time arranged with regard to economy of material, of space, and, above all, of the labour of attendance on stock and the other work done at the farmstead.

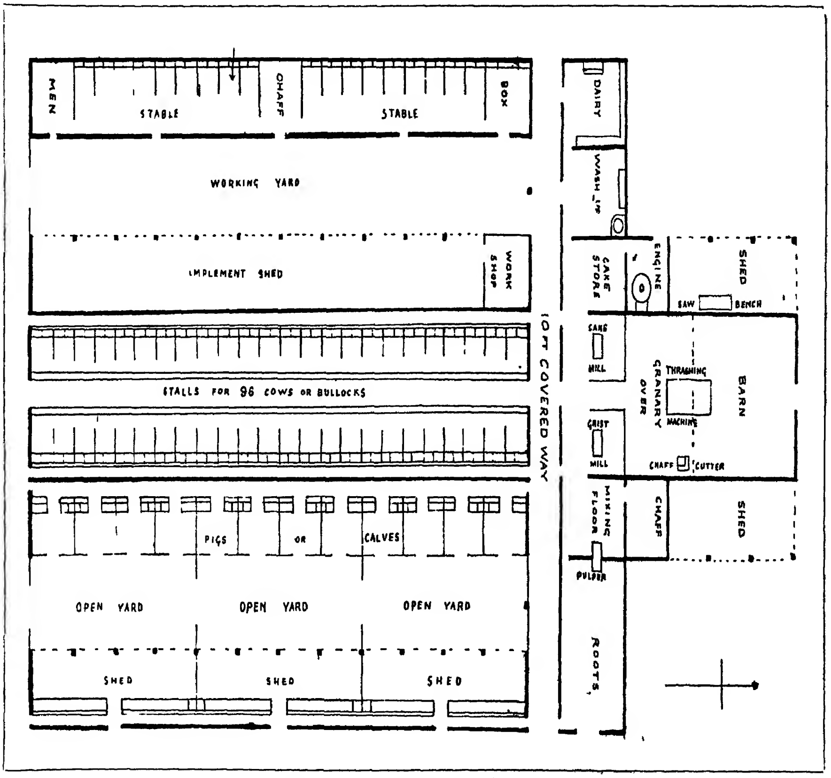

FIG. 1.—TYPE PLAN OF HOMESTEAD.

In the type or key plan here illustrated (Fig. 1), these matters are kept in view. In the barn range all the processes connected with the thrashing of grain crops, chaffing straw, grinding meal, breaking cake, pulping roots, etc., are arranged for, and can all be driven from the one piece of shafting connected with the engine in a convenient position, while a thrashing machine also could be fixed up in the barn in those districts where the fixed system is the custom. Again, owing to the live stock buildings being end on to the food-preparing department the rations can be easily trollied to the feeding troughs, or carried in baskets, as the custom is in some districts. There are sufficient open yards for young, dry, or fattening stock; sufficient loose-boxes or pens for pigs or calves; the central stalled shed will suit for either cows or fattening cattle tied up (the manure being run out the south-end door across a roadway to the dung pit), while it is sufficiently open for ventilation purposes, having open sheds on both sides; and the "working" yard has the work-horse stable on one side and the cart and implement shed on the other, so that there is a mimimum of labour in yoking a horse into a cart or implement of any kind.

The farm buildings generally are made of the one standard height of nine feet for the walls from ground to eaves. This is sufficiently high for all working operations, and not too high to waste building material, and any departure from this will be for special reasons.

3. *Open Yards.*—While open straw-yards must be enclosed round by buildings on several sides if possible, and while the manure in them is not objectionable, because it is kept littered over with fresh straw at intervals, the actual dunghill should be outside the buildings if possible. This is specially the case with cow or cattle dung produced by stalled animals, where the litter used is reduced to a minimum, and it is also the case with horse manure, owing to its fermenting properties. On the plan shown, the most suitable position is to the south end of the stalled shed, and across the roadway. In well-equipped homesteads the dung is now run out on a light tramway with trollies, while the most recent arrangement is the use of a trolly which runs on an overhead wire or rail, introduced from America. This will be explained and illustrated when we come to discuss the barn implements and machinery.

The erection of covered yards had a great vogue at one time, as it economised litter, preserved the manure, and was more comfortable for the animals, but it was found that animals so housed were less hardy when turned out to grass afterwards, while the expense of extra roofing was very great. A combination of open yard with shelter shed attached is now preferred to either the covered yard or

separate feeding-box, but all varieties can be included in the type plan illustrated.

4. *Stackyard.*—The stackyard should be placed to the north of the whole range, so that it is adjacent to the barn, and thus, whether the corn is thrashed by a fixed machine in the barn or by the portable set of tackle, the straw, grain, etc., are easily and handily put under cover. The stuff may or may not be stored in Dutch barns, that is, in sheds consisting of roofs carried on pillars and open all round, and these may or may not be connected with the barn by tram rails and trollies, but the gist of the arrangement is convenience of access for working. It is desirable to have a strip of plantation to the north and east of the stackyard and buildings for shelter, and to break the wind if there is not a ridge of land or a hill to give protection naturally. This will add much to the general comfort of the whole, and prevent the stripping of the thatch off the stacks, or the scattering of the straw by the winter gales.

By following the above-described principles in making new homesteads, or in altering and adapting old ones, the work of housing and handling all the live and dead stock will be much expedited, and the cost of labour reduced to the lowest efficient limit. Unfortunately the cost of building is often prohibitive, and the majority of farmers have to make shift and work away with homesteads built without any method, and at various periods in the past. A greater misfortune is, however, to see a new building—such as a cowshed—erected in the wrong place, and without any attempt to adapt it for convenient working. It is very seldom that professional architects know anything about planning farm buildings, while agents and landowners, from lack of knowledge of actual farm labour, are not any better. The farmer concerned, again, does not understand architectural drawings, his advice and requests are often ignored, and the total result is a piece of expensive muddling. A well-designed set of farm buildings may be worth half the rent of the farm, as it adds much to the possibility of a tenant making the most of his holding.

CHAPTER II.—BUILDING DETAILS

I.—The Farmhouse

The farmhouse, with its garden and other belongings, should be to the west or south-west of the working ranges if possible, but the site is generally regulated by the position of the whole homestead with regard to its general surroundings and the approach from the public road.

The house should be so situated, however, that a visitor would naturally come to it first, and not require to pass the piggery or the dungstead, or to go round behind a range of buildings to find it. It should face the west or south-west also, so as to be under the most genial influence as regards its frontage, garden, orchard, etc. It should not be far removed from the buildings—the width of a roadway or part of a garden is quite enough—for the easy access of the master to the homestead is absolutely necessary where visits are sometimes required by night as well as by day. Such things as the dunghill, the liquid-manure tank, etc., which at times are offensive, should be placed on the other side of some of the buildings, so as to keep the healthiness and amenity of the surroundings as good as possible.

The more detailed planning of the house and laying off the garden, etc., is outside the scope of this handbook, and it must therefore suffice to say that the matter should be treated as a case of erecting a detached villa, of greater or lesser size and style, according to the size and kind of farm for which it is required. One point is worthy of note, however—namely, that as a farmer never requires to work in his garden for the sake of exercise or fresh air, and as he cannot afford to keep a gardener, the ornamental part of the garden should be reduced to a minimum, so as to lessen the labour of keeping it in order. The kitchen garden part may be extensive, because an ordinary labourer can be turned in at intervals to dig and weed without any danger of doing harm, but the front part should be given over to shrubs and trees and lawns, for much flower bordering cannot be looked after.

These general rules apply to cottages for the workmen: they

should be a short distance away from the homestead buildings, and the site be one to give the greatest amenity and desirability to all concerned.

Such items as the nag-horse stable, the chaise- or trap-house, the hen-house, etc., are purposely omitted from the given plan because these are "appurtenances" of the dwelling-house and should form part of that range, and be separate from the steading proper, but if desired, these and other items can easily be included in the farm buildings.

II.—The Barn

Nowadays, the barn is often solely used as a granary for the storage of grain or other things until marketed, or as a food-preparing house, and, consequently, the great buildings at one time essential are not now so necessary. In olden times the grain was all thrashed there, and it was customary in many districts to have the building large enough to hold many acres of corn in sheaf, while a fixed horse- or power-driven thrashing machine occupied part of it, and there was a certain amount of room required for storing the thrashed straw for live-stock fodder. In our time, however, the advent of the portable thrashing and chaff-cutting tackle has rendered the barn comparatively superfluous; the straw is stacked outside, and only the grain and chaff are put under cover, so that really only a granary is necessary now.

There is a tendency lately, however, in many districts—especially since the introduction of oil- and petrol-engines or electric motive-power—to return to the use of fixed machinery. Where all the fodder is consumed on the farm it is undoubtedly the best system, especially in the north or in damp districts where the stacks are small. The carting of a stack in sheaves into the barn is a job at intervals during the slack time in winter for two lads and an old horse. The thrashing is done on wet days by the regular hands of the farm, and thus time and money are saved and the fodder is always fresh. On the other hand, where a lot of wheat is grown and the straw as well as the grain is sold off, the barn is wholly superfluous for the work, and the stacks are often built in the fields where the stuff grew, and are thrashed off on the spot—nothing but the grain being carted to the homestead, the rest being sold, or used to litter open yards.

Fixed Machinery.—It is of supreme importance to have all the fixed machinery in adjacent buildings in the barn range, so that one

engine or other motive-power can drive the lot from one shaft, either separately or together. There is a difference of opinion as to the advisability of chopping up fodder, pulping roots, grinding up grain, and so on, but the majority of farmers practise these, and, assuming that they require to be done, there may be immense saving of time and labour accomplished by having the necessary machinery properly situated. As shown in the plan, one shaft can be arranged so as to drive a series of machines, and these can be so fitted up as to give the maximum convenience and saving of space and labour in attending to them.

Where the barn range contains the compartments and machinery for preparing and mixing the food, a second story will be found desirable sometimes for storage purposes, while a fixed thrashing machine will also require a second floor. Where an engine is placed handy, a hoisting apparatus can also easily be fitted up, so that cake or grain can quickly be put up on to the top floor. On the other hand, there are many cases where the barn could be built against the side of a hill, the lower story partly excavated, and the upper story made accessible to carts or waggons by means of a raised roadway.

III.—The Stable

Stables nowadays are not built with lofts over them for the storage of fodder. This system used to be very common, but the open roof with plenty of ventilation is preferable, for fodder so stored was liable to become musty or tainted from the emanations below.

An open roof does not mean the bare slates or tiles as a cover only, but that the roof should be close boarded under these, thus leaving an open space inside with a sufficient number of ventilators on the ridge.

In some of the southern districts it is the custom for the work horses when "housed" in winter time, to run loose in open yards. A stable with mangers and stalls is attached, in which the animals are fed and groomed, and they are then turned out into the open yard (with shed attached) to run for the night. This system undoubtedly leads to making them healthy and hardy. It is suited to the southern country where the winters are mild, and the horses naturally of a quiet disposition, and does away with the perpetual cleaning out and brushing up of stables necessary where the animals stand continually in the stalls. In the plan submitted, however, the

stable contains stalls only, there is no open yard, and the manure has all to be wheeled or trollied to the dunghill in the usual way.

A farm-horse stable requires to be at least eighteen feet wide between the walls; the stall partitions should reach back nine feet from the wall to the channel—a small surface gutter to run off the liquid manure. The floor of each stall should slant about an inch towards the centre, and from head to tail as well, while the stalls, where single, should be from six to seven feet wide: this allows a clear nine feet for passage behind the horses as they stand tied up.

The manger may be one large trough running continuously along the front wall of the stalls, or it may be one half trough and one half fodder-rack to each stall. A convenient height is three feet above the floor, as a horse does not need to be restricted so much to one spot in standing and lying as does a cow or bullock. A rack on the ground level is preferable, because the overhead racks are difficult to handle and uncomfortable for the horses.

IV.—The Cowshed

The size and arrangement of the parts of the stall intended for either cows or fattening cattle is a matter of very great importance, and one which does not seem to be very well understood even by men who have been handling cattle practically all their lives, while it is still less understood by estate agents and professional architects—with very rare exceptions. The matter assumes greater importance in these days, when sanitary officials are making a great outcry about the production of clean milk on dairy farms, for there is nothing that conduces so much to this result as the adjustment of the cowshed and the stall to suit the cow, so that she shall naturally keep herself clean with a minimum of attention.

In a double shed it is essential to have the stalls set so that the cattle in the rows will have their faces to the walls and their tails towards each other, with a central dunging and working passage between. There are three reasons for this: first, if their tails are towards the wall, unless the gangway is exceptionally wide—as it must be in single sheds—their dung will be continually spattered against the opposite wall, and it will be impossible to keep this clean; second, if their heads are facing a central feeding passage there is the double chance of breathing vitiated air; third, in the case of cows especially, the milking, grooming and dunging have to be done from behind at any rate, and one wide central passage is much better for this

than two narrow side ones. As far as the feeding is concerned, this can also be done from behind quite as conveniently as from the front, and there is no great benefit to be derived from a feeding passage in front at all, excepting in the matter of ventilation. Feeding in front, indeed, requires great outlay in making the shed very wide roofed, and in fitting up the front of the stalls with arrangements for quick service of food—all of which are great drawbacks without any counteracting benefit. If the stalls are properly ventilated, as will be explained later on, the animals are better headed right up to the wall, and the cubic air space helped by having a gangway nine or ten feet wide down the middle.

1. *Width.*—In a double shed the measurements taken across should be as follows :—The feeding passages in front should be four feet wide; three feet is not enough room in which to run a trolly with food or to enable attendants while carrying baskets to pass one another. Then the stalls measured from front to gutter should be seven to eight feet wide, and the gutters two feet wide. These, with the central gangway of at least six feet, give a total of about thirty-three or thirty-four feet from wall to wall. If the feeding passages are dispensed with, then thirty feet will do. This, with the walls at, say, nine feet high to the eaves, gives a cubic air space of over 600 feet to each animal.

2. *Stalls.*—Then, as to the stalls themselves; for an ordinary shorthorn cow it is necessary to allow a bed of eight feet in length, measuring from the wall or partition in front to the edge of the gutter behind. This is the largest size required for ordinary cows, but for the smaller breeds—such as Ayrshires and Jerseys—seven feet is enough, and even less than that for the smallest individuals. As the cows, even in a very evenly balanced herd, will vary in size, it is desirable to have the stalls correspondingly variable, and the best way to accomplish this end is to make them of the larger size at one end of a row and of the smaller size at the other end; if the gutter kerb is laid straight between these two points, the stalls will graduate between these sizes, and thus every kind of cow can be exactly fitted to her size.

The tying chains should work up and down on a "traveller," or three-quarter-inch rod of iron fixed perpendicularly just above the outer edge of the manger, and there should be a swivel in it to prevent twisting when put hastily round a cow's neck. The chain should not be too long, and it should be well forward to the stall front as described, so as to prevent the cow from backing too much Attention may here be called to the American system of stanchions,

or neck yokes, whereby a cow has her neck held by parallel bars or ribs set on a swivel. She can move her head up and down and turn her neck sideways, but cannot go back or forward. This ensures that she will keep her bed clear of droppings, and adds much to her natural cleanliness.

The stall partitions (travis) may be made of wood or large flagstones set on edge, but nowadays "reinforced" concrete is becoming quite common, and makes an exceedingly good job.

3. *Mangers.*—The next point is to have the manger for food made on the floor level. It is a common but great mistake to have it built up more than is necessary to hold the food, and from eight to eighteen inches are the most suitable limits. The reason is that the animal must stand and lie on exactly the same spot if she is to keep herself clean, and the manger must therefore be low enough to allow her to lie with her head above it. If the manger is high, the animal must back herself to lie down, and will thus continually defile herself with her own droppings, whereas if she keeps one position the droppings fall into the gutter behind, and she lies clean.

The outside width of the manger should not exceed two feet, and eighteen inches is a better size. There is a supply in the market of half-round glazed pipes specially intended for making continuous channels for mangers, and these do very well when set in cement and the outsides filled up square ; but probably there is nothing better than all Portland cement concrete for the purpose. In some parts of the country, separate glazed troughs are used, so that each animal has its own lot of food to itself. With this latter style watering has to be carried out by some other special arrangement, whereas by the use of the continuous manger the watering can be done by running it in at one end and allowing it to flow all along. It is necessary in this case, however, to have the manger made perfectly level from end to end so that the water will fill it equally, and not all run to one end. If the shed floor has too much incline for level mangers, the troughing must be made in lengths at corresponding levels. Where the cows are turned out daily to be watered this does not matter, but watering in the house is much the best method for many reasons.

It is quite unnecessary to provide cows with racks for fodder ; if a forkful or armful of hay or straw is laid on the manger between the cows, they will eat it more conveniently than if put in a rack overhead, which makes them eat in an unnatural position, and the rack comes in contact with their horns. A cow

is not so dainty about her fodder as a horse, and she will clear up her allowance as a rule. If any inferior stuff is left, it can be pulled back for litter.

4. *Gutters.*—It is absolutely necessary to have a gutter both wide and deep behind the stands. The Dutchmen make these half a metre deep (19·6 inches) in their cowsheds, and thus have their animals practically on a high platform, but much less is considered necessary in this country. From six to eight inches deep with a width of two feet are the best dimensions. If the gutter ("groep") is made less than this the droppings produced during the night time will be piled up and mess the hindquarters of the cows when they lie down—a drawback that has to be specially guarded against—so that a depth of six inches is the minimum. As regards width, allowance must be made to prevent the animals from shooting their droppings on to the working gangway, and two feet is the minimum to accomplish this, while there must be room for the liquid as well as the solid manure. Another point is to slant the bottom sideways across the channel, so that the liquid shall run outwards from the animals to the outer side and still further improve their chance of keeping their tails and hindquarters clean. This slant may be as little as half an inch up to a whole inch in the width.

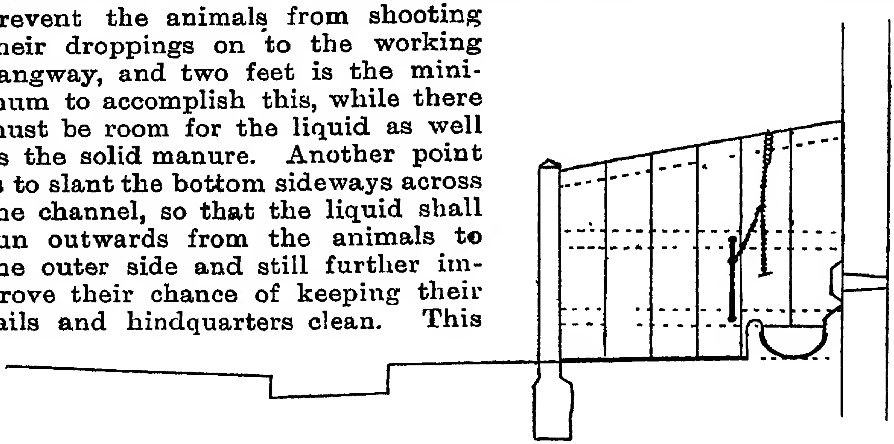

FIG. 2.—ELEVATION OF COW STALL.

Lengthways, of course, the gutter must have a fall to the outer drainage as well, and this may be as little as one-fourth of an inch per stall width of seven to eight feet. Bearing in mind the necessity of keeping the mangers level while running parallel with the gutter, the latter must not have a great fall, or else it will require corresponding adjustment of the stall generally and of the manger in particular.

If the working gangway is laid, say, three to four inches lower than the animals' beds it will improve their appearance by raising them on to a slightly higher level, while with milking

cows it improves the access to the udder in milking. The accompanying diagram to scale (Fig. 2) shows the arrangement recommended.

V.—The Dairy

The dairy ought to be large and roomy and well lighted. It should face the north if it can be arranged, and be lighted from the north side so that everything may be kept as cool as possible. The same type will suit all kinds of dairy work—new milk, butter or cheese, but in the case of the two latter a separate apartment is desirable for storage of the produce until fit for market. In addition there must be a scullery or washing-up apartment where hot water can be prepared separate from the dairy proper, though this may sometimes take the form of a lean-to shed. A complete dairy, therefore, requires from two to three apartments. In cheesemaking districts the dairy sometimes forms part of the farmhouse range for convenience of working by the members of the farmer's family. The main controlling factors are that it must be quite away from all yards, dungsteads, or other sources of contamination, while it must also be so situated that it can be isolated if an outbreak of infectious disease occurs in the farmhouse or adjoining cottages.

The most efficient dairies are those constructed with double walls and with the floor of concrete and the walls cemented some four feet high on the face. This allows of the whole being washed out copiously with water at frequent intervals, while whitewashing above the cemented portion keeps it sweet and wholesome as well as of a pleasant appearance. If the position of the dairy gives a cold exposure, the double walls may be dispensed with, but a cemented floor and wall-facing are necessary. It is a great help to coolness in summer if there is a layer of felt laid on the roof below the tiles or slates, while a further help is to keep both the outside walls and the roof whitewashed. The whitewash spraying-machine in universal use renders whitewashing an easy matter now, and a coat put on the slates or tiles on the roof of the dairy in the spring time will last all the summer. All the shelves in a dairy should be of stone, excepting those for storing cheese, which ought to be of wood—fitted in turning frames if possible. Stone shelves are most easily made of slate, but concrete slabs are coming into vogue, while it is worthy of note that Sicilian marble is almost as cheap for this purpose as slate, and is largely adopted now for dairies where the owner is tasteful in these matters, and butter is the chief product.

The drainage of the dairy must be arranged by slanting the floor to a trapped drain so that no taint may come near the building, while a good supply of water must be laid on.

VI.—Sheds

The other buildings comprised in a homestead are mostly sheds for various purposes, such as implement shed, the sheds for yard-stock and for loose boxes, piggeries, etc. To suit the general style of the homestead these may be from sixteen to eighteen feet wide and of a uniform nine feet in wall height. Implement sheds and cattle sheds need not have anything beyond an earthen floor, as this will always be dry, but where a building is partitioned off into pig pens it is necessary to make a floor to prevent the animals from rooting it up, while loose boxes also are much improved by a concrete bottom. In dividing off a range of buildings into loose boxes, or for pigs, calves, etc., it is not necessary to have the walls built quite up to the roof, or to have the latter close boarded, when the homestead is situated in the southern country, but in the north, with its severe winters, close building is desirable. A shed roof carried on pillars can always be conveniently made into loose boxes of any sort by fixing a framing of "quartering" and covering it over with close boarding.

When cattle are housed under such conditions, it is necessary to have a raised manger fitted up for feeding purposes, along the wall on one side. It need not be more than three to four feet high—set to suit the height of the kind of stock—the reason being that it must be above the litter which will accumulate when the animals are bedded from time to time. A rack for fodder will be suitable under such circumstances, as the stock have room to move about and loose fodder would be wasted.

Ridge-and-valley roofs must be avoided as much as possible, because of their liability to hold snow or blown rubbish, and eventually to leak. A high central building, with lean-to sheds at both sides, is the most convenient and efficient arrangement, combined with cheapness, and most of the manufacturers of corrugated-iron buildings keep the materials for these sheds in stock, while such timber and iron erections are about the best we can have for general farm purposes.

CHAPTER III.—FARM SANITATION

THE influence of sanitary conditions on the health and well-being of the farm animal was discussed in the volume devoted to live stock, so that it is here only necessary to study the methods by which these conditions are carried out in the building and mechanical details.

1.—Ventilation

In the United States and Canada—as well as in many of the European continental regions in which snow lies long and deep in winter—elaborate arrangements are made to ventilate the concentrated "barn," where the manure, the live stock, and the fodder are kept on stories one above another. Ventilating shafts called "chutes" are built up from the cattle compartments to the ridge of the building, and on the top of these revolving cowls turn to suit the wind, so that the vitiated air flows up and out. These chutes generally open inside the building close to the floor — also near the heads of the animals—and the vitiated atmosphere is removed irrespective of the tendency of warm air to rise. In this country such a system is useful only in those districts, limited in number, where there are lofts over the animals—a style not now approved of. It is necessary, however, to have ventilating openings in the roof, and the system of a box or frame on the ridge with louvered sides is the most convenient. (See Fig. 3.) This gives ready egress to the used air, which tends to rise because it is warm, while the cross draught from whichever side the wind blows helps to draw it out. One of these ventilating tops, say two feet square, to every twenty animals is enough as far as the top ventilation is concerned, but the bottom ingress of air is equally necessary.

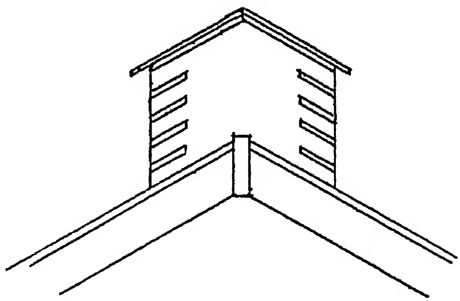

FIG. 3 —RIDGE VENTILATOR.

Stall Ventilation.—For cattle in stalls and horses in stable an opening—at the level of the animals' noses—straight through the wall is the best. To prevent direct draught the inner end of the opening may be shielded by a flat board or sheet of iron, which will deflect the current of air when it blows inwards, so that there is no actual draught, while the animals get fresh air at their noses, just where they want it. As explained in the volume on "Live Stock," the outer end of the opening should be smaller than the inner, in order that the force of the current of air inwards may be lessened. A sheet of perforated zinc outside and inside will still further lessen the force of incoming air, and reduce the chance of draughts. (See Fig. 2.)

These stall ventilation openings may be, say, five or six inches in diameter on the internal side of the wall, and, together with the roof and other openings, will be sufficient to keep the air of a stable, cow-house, or other cattle building in a healthy condition.

The "wall-head" ventilators, which are common in some districts, are very useful, but the system whereby the fresh air is delivered in each stall near the ground level, and then driven out at the ridge of the roof, is, as yet, the best plan.

It necessitates, of course, that a cowshed shall stand by itself, or at the most, have open sheds along the side walls, but this is a point required by some sanitary officials, and is provided for in the plan submitted above. Even where feeding passages are arranged at the animals' heads, the low ventilating openings in the walls opposite are desirable.

Adjustable ventilators have one great drawback, and that is they need to be adjusted. The great majority of stockmen—especially cowmen—believe in keeping every opening shut so as to get up the temperature, and cannot be persuaded that a warm shed is an unhealthy one. When, therefore, a ventilator is shut in stormy weather it will remain shut when the storm passes, unless the master sees to the opening of it. Permanently open ventilators, or at least those which act automatically, are therefore much to be preferred.

A large cubic air space is preferable in all buildings closed in—such as stables and byres—because it helps the ventilation and healthiness, and modern experiments have shown that a comparatively low temperature—down even to 40° Fahr.—is quite compatible with successful feeding or milking in winter-time. About 500 to 600 cubic feet for a cow, however, and 800 to 1000 for a horse is amply sufficient.

II.—Lighting

For lighting it is a good rule to put in as much glass as possible. Nothing is more conducive to the health of animals than plenty of sunlight, which is the greatest preventive of diseases. In the hot summer-time it is principally milk cows that are kept indoors for a few hours daily. To prevent torment by flies, shade is very necessary, and under such circumstances the glass can be white-washed over with the sprayer, and the lime afterwards cleaned off when the dull days return.

As a rule the windows require to be high off the ground so as to be out of reach of the animals, and roof windows are desirable because they are cheaply and easily placed, and at the same time can be readily opened and shut by means of cord and pulley. A gable gives an opportunity for fixing a lot of glass, giving light down a whole building, while shallow side windows may have ventilating apparatus connected with them. Indeed, a pivoted window which can open with a slant inwards at will, is one of the best forms of adjustable ventilation and lighting combined. In a single-row building these windows come best in the wall behind the animals, as direct sunlight in their eyes is not desirable. In many districts, where pantiles are used for roofing, glass tiles of the same shape and size are used, and the substitution of these for the ordinary tiles is one of the most convenient methods of lighting from the roof. Even where slates or plain tiles are used this plan can be followed with plain sheets of glass, if the roof is formed of slats and is not close boarded. About two square feet of window must be allowed per head to the stock in the buildings.

III.—Drainage

The proper drainage of the homestead requires two sets of drains, one for the rain water and another for the liquid manure. Much, of course, depends on what is to be done with the water. Rain water may be usefully collected in tanks or underground cisterns, and the surplus allowed to escape into the nearest ditch. Liquid manure, on the contrary, should be kept out of the ditches as much as possible, and it may first be gathered into a liquid manure tank and the over-flow led out on to the surface of a grass field, if possible, and allowed to soak away. Liquid manuring either by contour irrigation as explained in the volume on "Soils," or by carting out and distributing by water-cart over the surface, has never been a conspicuous success.

The workmen do not like the nasty, stinking job, there is a big outlay in making the necessary cistern with the drainage leading thereto, and the results to the crops are disappointing. Thus it comes about that on very many farms elaborate arrangements made to utilise the liquid manure are now standing idle, and the sewage is run on to the land simply to get rid of it as easily as possible.

All the buildings of a homestead ought to be spouted, that is, be fitted up with eaves-gutters or rhones, and the water led away in underground drains. There are several objections to leaving the buildings without guttering: the drip from the eaves is a great nuisance and discomfort to both animals and their attendants when leaving and entering, or doing anything near an outer wall: it keeps the pathways in a sloppy mess where necessary to pass alongside under the eaves or to enter doors; it rots the timber of the walls; and where there is a cattleyard attached, the delivery of the rain off the roofs wastes and washes the manure more than rain which falls direct. Many farm buildings are only partly spouted, and to do the whole would be a great expense, because though the mere purchase and screwing on of the rhones below the eaves with the necessary down spouts would not be very expensive, the making of a complete system of underground piped drains to carry off the water independent of the sewage drains may be a very expensive job indeed.

Sewage or liquid manure drains should be open where possible. Where a drain requires to pass across a gangway or roadway it must be closed in, of course, but elsewhere an open channel is best for ventilation and keeping the passage clear. Where a closed drain must be made, glazed socket pipes are essential, and there should be frequent cesspools or inspection openings, especially where a change of direction occurs. In many instances, inspectors of cowsheds very foolishly insist on open channels for the liquid manure inside the sheds, but outside the drains must, of course, be covered in some places. Six-inch glazed earthenware pipes are the best for this purpose, and all bends or curves should be avoided. If laid in straight lengths, with cesspools or inspection holes covered with a flagstone at the point where there is a change of direction, they can easily be kept in good working order.

The best form of liquid-manure tank is one made in the shape of a long trough some seven or eight feet wide and not more than eight feet deep, and the space obtained by making the length to suit. The size should be sufficient to hold ten days' liquid, which is reckoned at two gallons per head daily for the live stock housed

plus, at least, 30 per cent. for the unavoidable drainage of open yards, dungsteads, etc., which should all be led into it. This means that the size should be at the rate of about four cubic feet as a minimum to every head of stock. The material of the sides and bottom may be concrete, or nine-inch brickwork set in cement. A tank of this description is easily covered over by old sleepers or slabs of wood, and it ought to be situated outside the site of the buildings, or behind a blank wall, so that any emanations from it—especially when being emptied—may be well away from the other buildings. If the liquid is to be carted out, then a chain pump and platform will be necessary, and the whole should be fenced in. Usually however, in practical work the reservoir becomes a settling tank where the solids gradually decompose from bacterial action, and only the effluent water runs off at the overflow to be spread over the nearest part of a field.

IV.—Dungstead

The handling of the dung, either in the daily removal from the sheds to the dunghill or in carting from the dunghill to the field, is one of the greater jobs on the farm. Apart altogether from the manurial value of the solid and liquid excreta of the domestic animals, it must be removed daily, if not twice daily, from the buildings where the animals are housed, and an immense deal of washing out with water and whitewashing of walls and fittings must be carried out as well. In the case of fattening and store cattle, this labour is avoided by keeping them loose in yards with a shed over the feeding troughs, and where they are kept well littered they thrive and remain healthy. The fermenting litter and dung in an open yard or shed do not seem to work any harm so long as they are kept supplied with frequent supplies of fresh straw. This plan is successfully followed even with milk cows as well, but these require to be taken into separate stalls in another apartment for milking.

The yard system of feeding certainly removes the necessity for much of the labour in tending live stock, and at a farm of this kind there is no separate dungstead required at all, and very little liquid manure flows away. For stalled cattle, however, and especially for cows, the requirements of a proper dungstead must be attended to.

The increasing strictness of sanitary science is making the position of the dungstead, and the handling of the dung, matters of the

first importance. In the olden times a shallow channel to carry off the liquid manure into the nearest ditch, and the piling up of the dung in a heap just opposite the door of the cattle sheds, were considered quite enough. In many old homesteads the buildings were ranged round the four sides of a square, and the dungstead was a hollow in the centre to which the manure was wheeled from all the byres and stables. Nowadays we insist on the site being outside altogether and, if possible, across a roadway, or at least several yards clear of the buildings, so as to reduce the chance of taint to a minimum. Where money is plentiful, the owner may erect a covered shed for the dung, but it is questionable if this is worth the trouble and expense. Where the water from the roofs is kept away from it, the ordinary rainfall is no more than sufficient to keep it wet and in a proper state of fermentation, as may be seen when a heap is carted out and piled up in the field: observation shows that very little liquid drains away from it. On the other hand, the manure is apt to become too dry under a roof, though the same roof can often be utilised as a temporary shelter for pigs or implements. If there is plenty of space at the site of the dungstead there will be no need for a wall around it, but if the area is contracted, then a wall—well buttressed—must be built. The bottom (slightly hollowed out) may be laid with gravel or road-metal rammed tight: concrete or paving being quite unnecessary, the object being simply to make the floor good enough to carry carts when the manure is conveyed to the fields. The neighbourhood of the dungstead is of course a suitable site for the liquid-manure tank.

A dungstead should be large enough to hold more than one season's complete dung product. This is necessary because in some wet years it is impossible to cart it out to the fields, and thus provision must be made for extra storage. It is a great waste of labour to cart out manure to pile up so as to have to load it up again: the manure is better left where made till wanted on the land direct.

CHAPTER IV.—FIELD-MAKING

In the olden times the country was all open forest or moor, and the cultivated land was only in patches here and there, from which the live stock was kept during the growing season by shepherds, swineherds and others. At various times, but particularly towards the end of the 18th century, many Enclosure Acts were passed which enabled owners and occupiers to confine their lands with fences of various kinds, and from that time onward the making of the Fields, with their accompanying Fences, Ditches, Gates, Roads, etc., has been proceeded with.

I.—Fields

It is an exceedingly great pity that our forefathers had not better ideas on the laying out of land for farming purposes, for they seem to have run a ditch and bank round a piece of land without any idea of making straight lines or of fitting a field for easy and convenient work. They appear to have enclosed a few acres at a time from the surrounding waste without taking the least trouble to lay it out even or square. One can understand a fence or boundary being crooked or irregular where the natural features, such as a stream or a broken or rocky piece of land, prevented the adoption of straight lines, but even where the ground was plain and regular our ancestors seem to have gone into the job with their eyes shut. When the era of larger farms set in, and the working of larger fields became necessary, the plan followed was to take out some of the intermediate fences, and leave the outer ones as a ring to a larger field. The result of all this is that in our day about four out of every five farms all over the British Islands are handicapped with irregular-shaped and irregular-sized fields. To clear these off and re-make the whole is too great a work nowadays, and would seldom pay, though it has been done by some owners and tenants in some districts.

In a new country where the farmer starts with the bare land—as on the prairies of the West—he can lay off his fields or arable parts properly, and therefore on such we find that whole farms are

either perfect squares or oblong rectangles, and the cropping land laid out the same way—at least as far as the natural features will allow. This is the principle that ought to have been followed in our own country, but unfortunately was not. The small farming of village communities with small and irregular enclosures was followed by larger farms, but unfortunately the small fields have left their mark, and it would probably take an expenditure of from £2 to £3 per acre to dig up the old fences and re-lay off the land into convenient rectangular fields. The filling up of old ditches, cutting down hedge trees, planting new lines of fences with probably a ditch alongside, erecting protecting wire fences till the new hedge grows, etc., is further complicated by interference with and rectification of the drain pipes below, as the drainage has often been laid down to suit the old fields, so that the work is now well nigh impossible excepting in limited or special cases.

Number and Size.—It is desirable that the number of fields on a farm should suit the rotation of crops that is adopted. Manifestly, a five-course shift could not fit into, say, seven fields without getting into a complication, as it were, and thus in practice a rotation has often to be adopted according to the fields available, as it is easier to do this than to alter the arrangement of the fields. To have part of a field in one kind of crop and part in another is not desirable; it is better to have all in one thing, and thus rotations are often ruled by the number and size of the fields.

While the number of fields and the rotation of crops should be adjusted to one another, the most suitable size of a field is about 20 acres, and a suitable width is about 300 yards. There can be no hard and fast rule in these matters, however, but these are desirable dimensions. The larger the fields the more suitable for steam cultivation or for the future development of motor-driven implements, but whatever the size, a width of about 300 yards suits the drainage and the pulling strength of horses best.

If the fences are not straight, it is almost imperative to have one straight fence at least, from which to start the ploughing of the ridges, the drilling, and all other arable work parallel to it. This throws all the "points," or short triangular lands, at the finish to one corner and thus expedites the work.

It is desirable also, if the slope of the land and other features permit, that the fields should lie square to the points of the compass. The object of this is to allow the ploughing, the making of ridges and the setting of stooks of corn, to be made north and south, so that the sun may get equally to both sides of a growing or cut crop. Awk-

ward corners, such as alongside a stream, might be got rid of by fencing off and planting with suitable trees, and in view of a future timber famine and the development of forestry, this is one of the best things to do. Indeed, the planting of all irregular pieces, "broken" land, and places that cannot be conveniently included in regular arable fields, is a good policy for all landowners to follow, but it is, of course, outside the scope of tenant-farming. This work and the planting of strips for shelter and for otherwise improving the amenities of a farm was previously advocated in the volume on "Soils."

Where the land is constantly arable, and no rotation grass is grown for pasture, the fences may be dispensed with altogether, and the land left in wide stretches as is seen on some of the "carse" farms of the north.

In the case of pasture land there is not the same necessity for troubling about the rectangularity of the fields, or the number or straightness of the fences. A paddock or two near the house for horses and other stock is necessary, and convenient access to water often rules the arrangement of the grass land.

The areas of all our fields have been authoritatively ascertained by the Ordnance Survey, and every farmer would be well advised to procure the sheets for his farm, together with the accompanying "area book." He will get the exact acreage of each enclosure, and find much other useful information about his farm. It is to be remembered, however, that the areas are computed from the centre line of the fences, and as there is sometimes a space of several yards from the cultivated land on one side to that on the other, it follows that the land actually arable may be from a half to a whole acre less in a field than the Ordnance measure. This point must be taken into consideration in valuing the rent of a farm, in letting piecework to labourers, and in seeding or computing the crops in any way. A fair allowance is a rebate of one acre in a twenty-acre field, but it can be found exactly by measuring round and taking the average width of the waste land.

II.—Fences

In former times the usual way of making a fence was for the maker to dig a ditch at the boundary of his land, to throw up the earth on his side of the ditch and thereon to plant the quicks. The fence was for the purpose of keeping in his own stock, and legally his neighbour had no right to make use of it, but had to erect a fence

of his own if he also kept stock. Fortunately, neighbourly feeling prevails in most cases, and the matter is seldom in dispute, and one fence serves both sides, while, however, it belongs to only one side and is repairable only by the farmer or owner on that side.

In cutting or clearing out an open ditch it is a good rule to put a considerable slope at the sides. Each kind of earth material has its "angle of repose" at which it will remain without slipping down or being disturbed much by the action of rain or frost, but in a farm ditch it is the treading in by the stock and the pressure of vegetable growth that has to be seen to most.

1. *Hedges.*—While a ditch was necessary in the olden days before underdrainage was common, it is not so necessary now, and hedges may be, and often are, planted on the flat. A strip of soil a yard wide is trenched or subsoiled by spade work, and along the middle of this the thorn quicks are set in a row with the plants six inches apart. On clay soils, however, open ditches are generally necessary for the removal as quickly as possible of surface water, and in many cases to take the discharge of water from the drains. Where they take the pipe drainage, therefore, they must be at least three feet deep, but less will do for surface drainage.

The drawback to a thorn hedge is that it requires yearly trimming to keep it properly, while if allowed to grow out of order it needs a lot of work to "plash" or "lay" the branches to fill gaps and make good again, in addition to the first expense of planting and making protective temporary fences.

There are many districts, especially in hilly and rocky places, in which thorn fences are not so desirable as stone dykes. Where the land has had to be cleared of loose stones before cultivation, or where stones lie plentifully at hand, the dyke is the best form of fence. It is finished from the very first, requires no balancing ditch, forms a shelter straight away, and needs no protection or yearly trimming to keep it in order. Its great drawback is the expense in construction, so that nowadays very little stone-dyking is done.

Where timber is procurable on the spot there are endless varieties of wooden posts, rails, and paling, which can be adopted, but the use of these has declined, unless under special conditions, since the development of iron-wire fencing.

2. *Wire.*—For modern field fencing, where shelter is not absolutely necessary, nothing is better than the "woven-wire" (see Fig. 4) now on the market. It is formed of strong galvanised wire, and the cross-joints are electrically-fused so that the whole forms a powerful

net which will keep in all classes of live stock—even pigs which are usually very difficult to confine in a field. Any width is obtainable, but probably the best form is about three feet high, with either one or two barb wires fixed above it along the top of the posts. Owing to its being easily climbed, the barb wire is necessary to keep trespassers from getting over. The posts may be put from twelve to twenty feet apart, and the whole gives one of the cheapest and most efficient forms of fence yet invented.

FIG. 4.—WOVEN-WIRE FENCE.

The wire part may cost about fourpence per yard, but the timber posts ought to be procured on the farm at the cost of the labour only. A few trees felled, cut into lengths, and split with wedges into suitable sizes will supply posts for letting into the ground, on to which the wire is stretched, and the whole can be done in the slack time of the year by the regular men on the farm at a minimum expense.

3. *Hurdles.*—Hurdles for the making of temporary fences are exceedingly useful, and an assortment of these are very necessary on a farm. The best and most useful are the twelve-feet long iron ones running on four wheels · they cost about a pound each when new, but are exceedingly handy as temporary gates, or as fences for sheepfolding where they require to be moved daily, or for putting round stacks in the fields. At the other extreme are the small six-feet wooden hurdles made of split rails and costing, new, about a shilling each, while there is an endless choice of iron and wooden forms between those two varieties.

4. *Gates.*—A field or a fence must have a gate as part of the fitments, and the life and efficiency of it depends largely on being constructed on correct principles. The elements of every gate are comprised in a triangle composed of the heel-post, top-rail, and diagonal strut: these are the essentials to give strength and to prevent sagging down, and the rest of the gate, to make a rectangular

construction for fencible purposes, may be filled in on almost any pattern—usually with parallel rails or bars.

Gates should be ten feet wide between the posts, so as to admit easily the wide, modern implements we use nowadays, and the gates should be hung so as to open quite back to the fence. If the posts are creosoted and set in concrete they will be everlasting.

There are a legion of kinds of gate-fasteners on the market, and new ones are brought out almost every year, but a really good one which will not readily get out of order has not yet been designed. Every district has its own general pattern in common use, however, and most people will find it convenient to adopt that best known in their own locality.

III.—Roads

The possession of good roads adds much to the amenities of a holding, besides expediting the daily work. As a rule, the only road worthy of the name about a farm is that leading from the public highway to the homestead, but one well metalled right through the farm from which all the fields are accessible is a very great benefit indeed. Since the advent of the motor-car traffic the existence of a public road through a farm is a very doubtful advantage, however, and one with the fields abutting on a private road is much more to be desired.

1. *Materials.*—The sufficiency and quality of farm roads depends almost entirely on the nature and plentifulness of local material for making them. In a clay district they are generally of the worst quality, while in a region where granite, bluestone, or other hard rocks predominate the roads ought to be of the best kind as far as material is concerned.

In many districts the fields were originally covered with stone—the wreckage of the boulder clay or some other geological formation—and these had to be cleared off before the land could be cultivated or even properly grazed The most convenient way to do so was to build these into stone dykes and make the bottoms of roads therewith. (See the volume on "Soils," p. 71.)

The making of a farm road of the width of eight to ten feet for the metalled part is an altogether different matter from the making of a public road, where expense is not a drawback with the local rates behind it. Properly broken granite, bluestone, flints, or similar material can be brought hundreds of miles, and steam-rolled in to make a solid public roadway suitable for rubber tyres;

on a farm the material at hand must be used, and all sorts of makeshifts adopted.

There is no better method of making a farm road than to first lay a foundation of large stones, and then fill up the top with small ones, or broken ones for choice, but this can only be done where stones and gravel are to be had free of initial expense. Failing these, in many clay land and other districts, roads have to be made by first of all laying a bed of faggots side by side across the line of roadway, and as wide as the metalled part is to be ; on the top of this a sprinkling of straw is put, and then about eight inches of gravel, flints, or burnt clay topped with gravel. A hedge of long, straight stems of thorn or anything else comes in very handy for making the faggot bundles for this purpose. A bottom of this sort is practically everlasting, and helps the drainage. Burnt clay topped with gravel is sometimes the only thing available ; the point to be attained is to have self-draining material as far as possible, and to keep the road high and rounded in the middle.

The cost of road-making is not so great on a farm if the materials can be got cheap and convenient, because the labour can be done at slack periods of the year. Thus, making small pieces of new roadway about a farm, or repairing old ones, is not so great an undertaking. An extensive length of roadway, however, is a serious matter, and requires a very large outlay of capital. The accessibility to a quarry or a gravel pit within carting distance regulates the whole matter, however, as the labour part can generally be easily carried out.

Failing a sufficiency of suitable material on the spot, ordinary earth roads have to be put up with on farms, and these may conveniently be headlands at the same time, so that every field shall be accessible. An earth road is best when on old turf, and if possible should not be carted on in wet weather, while the ruts should be levelled in from time to time and the whole rolled. In dry weather or frost these roads serve as well as made ones, and are the only kind possible in many of our fields.

A well-made public road will do with a convexity of one inch to the yard, but on occupation roads much more must be allowed, and the centre well rounded up so as to shoot off the water to help to keep it dry. There must be side channels to run off the rainfall, but these need not, however, be above a few inches deep. If a regular ditch is required it should be on the other side of the hedge, so as to lessen the chance of cart accidents, while a margin of at least, say, four feet of grass on either side of the metalled part is desirable.

2. *Culverts.*—The ditches, brooks, and streams about a farm require to have an endless number of roadways or headlands carried over them, and a few words regarding these must be given. A regular bridge over a stream is a big affair, and rather outside the limits of ordinary farming, but such things as culverts at gateways and roadways over ditches probably exist by the dozen on every farm, and the making or repairing of these is one of the annual jobs. For such, nothing suits so well as a large drain pipe: a dozen pipes, each a foot long, will do for any ordinary roadway. If these are laid end to end, and well bottomed in the ditch, and the latter filled up with earth to the surface level, they will never get out of order. The actual roadway on the top will of course be made in the same way, and with the same materials, as the other roads.

A six-inch pipe will carry all the water in an ordinary ditch, but any size up to twelve inches can be easily laid, and makes the most economical method of bridging. Above twelve inches diameter, it is probable that a concrete pipe would suit best. The making of a concrete culvert in the place intended for it is not so convenient as the making of a regular pipe which can afterwards be lowered into its place. Any handy labourer can make a mould with a few boards whereby the pipe can be formed of concrete and afterwards dressed before it is quite set. The "metal" of the pipe may be from two to three inches thick, and it may be made in two-feet lengths. A fairly large culvert or actual bridge over a stream may be made with Portland cement concrete shaped by fixing a mould of boards, and any handy labourer about the farm could do the work, after a lesson in mixing the concrete and fixing the moulding boards. No one, nowadays, would think of building a brick or stone culvert, unless under exceptional circumstances, because these require a skilled workman and the materials are expensive, while the erection in a very few years gets broken down and requires repairing. The adaptability of concrete for all purposes of this kind is very great, and recent developments in its use for culverts, posts, troughs, cisterns, gutters, floors, etc., is one of the great advances in the equipment of the farm with good lasting fitments.

CHAPTER V.—DRAINAGE AND WATER SUPPLY

In the preceding volumes of this series, the influence and effects on the soil, crops and live stock, of draining the land, and the value of an efficient supply of good water, were described; how the work connected with the carrying out of these should be done now remains to be explained.

I.—Drainage

When draining was first adopted in the olden times all sorts of methods were tried, but finally it was found that the only satisfactory plan was that advocated by Smith of Deanston, in Perthshire, whereby lines of drains at equal distances apart are run in parallel rows up and down the natural slope of the land at the moderate depth of about three feet. These are made to discharge either directly into an open ditch or into larger "main" drains laid up and down the hollows of a field or along the bottom side, which in turn are made to discharge at convenient points into the nearest open watercourse.

The distance apart of these parallel drains and the particular depth the pipes are laid depends on the nature of the soil. Where the subsoil is a sand or a gravel, and one therefore in which water percolates easily, they may be fifty feet apart, and, say, four feet deep, while at the other extreme we have to put them in at, say, fourteen feet apart and two and a half feet deep, on dense clay. Even this latter closeness and shallowness is not enough on some soils, and surface drainage, in the shape of ploughing the land in narrow ridges or "stetches" with open furrows between, has to be adopted, and with many extra water-furrows in addition. Theoretically, these narrow high ridges should be done away with when land is underdrained and subsoiled, so as to let the rain water percolate down easily. In many cases, even on stiffish lands, this is so done, but on many of the clay formations of England it is necessary with winter crops, like wheat, to arrange for this surface drainage in addition, for if the land were farmed on the flat in wet weather the water would hang about it all the season, and stagnate and kill out

the crop. Subsoiling, as explained in the volume on "Soils," would of course help very much in allowing the downward percolation of water, but that is a very expensive and tedious kind of work to undertake, and can only be done a little at a time.

1. *Laying Off.*—In proceeding to drain a field, the lowest point from which to start is found, and a main drain is dug up each hollow, at about three inches deeper than the gathering land-drains are intended to be. A clear outfall should be made, and a larger size of pipe tile used according to the rainfall to be run through it and to the acreage: the usual size being three to four inches diameter. The side or small drains discharging into this are cut up and down the slope of the land to suit the same, and at regular intervals. (See Fig. 5.) It is a great convenience, and much reduces the cost of digging, when the field lies so regular that the ordinary ploughing furrows come in properly as the site of each drain, but this cannot always be accomplished. The lines of drains can always be ploughed out with two furrows, however, and this helps the manual work very considerably. These gathering drains should then be dug out to a depth of three inches less than the main drains, and this depth will be from thirty inches up to, say, thirty-six inches in ordinary cases; the stiffer the soil the less the depth. It is a mistake to put them in too deep, and much money was wasted in the early days putting drains in at a depth of four feet where two and a half only would "draw" the water, and many farms have had to be redrained at the lesser depth. Another difficulty regarding this point is the keeping of the outfall clear; ditches from two to three feet deep can be kept clear without much trouble, but those from four to five feet are a very serious matter indeed, and are constantly getting blocked up.

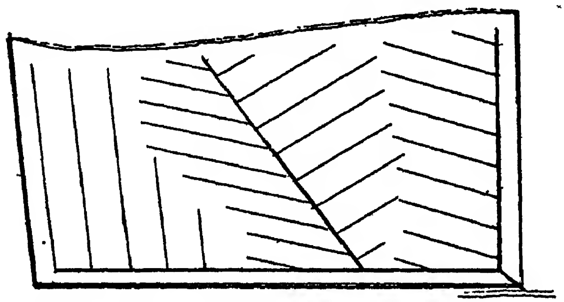

FIG. 5.—PLAN OF DRAINAGE OF A FIELD.

2. *Fall.*—The drain is dug out with a deep, narrow spade, and tapered downwards so as to be just the width of the pipe at the bottom. Of course it must be done so that there is a proper and even fall from end to end. Generally our fields are undulating or

sloping enough to give plenty of fall without any trouble, but occasionally land is so level that it requires testing with a levelling instrument and sighting rods to make sure that a fall is obtained. While drains will run with a fall of 1 in 400, in actual practice they should never be less than 1 in 200. The fall can be helped a little by making the drains as little as two feet deep at the upper end and three feet or over at the outfall if the land is very level.

3. *Pipes.*—The kind of pipes used for the ordinary parallel gathering drains vary in different parts of the country, but the cylindrical ones are the best. Theoretically, a pipe of an oval or elliptical bore is the best for promoting a scouring current, but in small drain pipes there is no appreciable benefit in this, while pipes with any other than circular section require one or two flat outsides on which to lay them. These flat outsides are a drawback for even and easy laying; the round pipe can be turned and fitted any way, while the bottoming scoop cuts out a round channel just to hold it, and it sits firm and true without any further care or packing and treading.

Where outlets discharge into a ditch it is a good plan to lay three- or four-feet lengths of iron piping; any old pipes will do for this—such as old steam boiler flues—provided they are of sufficient diameter. This piping makes a finish which will last without displacement.

All pipes should be hard burnt, for if not so treated they will collapse and ruin the drain when laid in the ground. A good test is to take pipes which have been lying for some time in a heap at the tile works or elsewhere; if they have stood the frost and weather without breaking up they will be all right.

The ordinary diameter of the bore of a common field-pipe tile is two to two and a half inches. Theoretically, one inch will carry off the rainfall under all ordinary circumstances, and pipes this size were made and used in the early days, but long practical experience has shown that pipes of the above size keep open, and fit together, much better than the small ones, and make a more permanent job.

4. *Cost.*—The expense of draining a field or a farm has amounted to an enormous sum of money, and in many cases it has cost from a half to the whole fee-simple value of the land for farming purposes at the present time. The bulk of the work was done in a former generation, when values were different from what they are now, both for labour and land. The accompanying table gives an idea of the total and relative cost of draining at different depths and widths and on different soils, reckoned on a basis of three

DRAINAGE DATA

Kind of Soil	*Depth in Feet*	*Distance Apart in Feet*	*Rods per Acre*	*Cost per Rod, Cutting and Filling.*	*No. of 12-inch Pipes per Acre*	*Cost of Pipes plus Carriage, at 30s. per 1,000*	*Cost of Laying per Acre*	*Cost of Cutting and Filling per Acre*	*Cost of Mains per Acre*	*Total Cost per Acre*
				d		£ s d.	s. d.	£ s. d.	s. d	£ s d.
Very Stiff Clay . .	2·5	12	220	8½	3630	5 9 0	13 7	7 15 4	3 6	14 1 5
Stiff Clay . . .	2·5	15	176	8	2904	4 7 0	11 2	5 17 4	3 6	10 19 0
Friable Clay . .	2·5	18	146	7½	2420	3 12 6	9 1	4 11 3	3 6	8 16 4
Soft Clay . . .	2·75	21	125	7½	2073	3 2 0	7 10	3 18 1	3 9	7 11 8
Loamy Clay . .	3·0	21	125	8	2073	3 2 0	7 10	4 3 4	4 0	7 17 2
Loam and Gravel	3·25	27	97	8½	1613	2 8 0	6 0	3 8 8	4 3	6 6 11
Light Loam .	3·5	33	80	9	1320	1 19 6	5 0	3 0 0	4 9	5 9 3
Sandy Loam . .	3·75	40	66	9	1089	1 12 6	4 1	2 19 6	5 1	4 17 2
Sand and Gravel .	4·0	50	52	9¼	871	1 6 0	3 3	2 1 2	5 7	3 16 0
Coarse Gravel . .	4·5	60	44	10	726	1 1 6	2 9	1 16 8	6 3	3 7 2

shillings per man per day for wages : an average figure being half-a-crown per chain for cutting and filling a drain thirty inches deep.

5. *Mole Drains.*—On stiff homogeneous clay soils the system of "mole draining" has long been successfully practised. In this system a plough frame is used, in which is fixed a large coulter with a conical shaped enlargement or plug (the "mole") at the lower end. This is set at the depth required for the drain and the "plough" is pulled through the soil, either by a horse-driven windlass or a ploughing engine. It forms an open channel some three inches in diameter in the clay, and this will remain open and thoroughly drain the land for a number of years. These "mole" drains either discharge directly into the ditch along the bottom of the field or into a main piped drain laid for the purpose. The expense is comparatively small, say thirty shillings per acre at twenty feet apart, but it can, of course, only be done on a homogeneous clay, and a heavy engine must not pass over the land ever after for fear of squeezing the drains together.

6. *Hill Drains.*—On the open hill country "sheep drains" are the common method of draining adopted. These are usually cut twenty-four inches wide, sixteen inches deep, and six inches wide at the bottom, and are left open, with the turf taken out and laid alongside clear of the cut and the clearings thrown beyond. They are usually made from nine to thirty-five yards apart, according to the nature of the ground : the land in such cases must not be over drained for fear of destroying the sheep mosses that grow and feed the sheep early in spring.

II.—Water Supply

As mentioned previously in the volumes on "Soils" and "Live Stock," a supply of good water is absolutely necessary about both the homestead and the fields. It is here now desirable to explain how water is to be procured for this purpose.

1. *Contamination.*—The great outstanding fact to be kept in view in arranging for a water supply, is that it must be free from all sewage contamination. Out in the open country it may be thought that there would be no difficulty about this, and in the case of sparsely populated districts, or on farms on the hills, there probably will be none, but in most other cases there may be some trouble. The ordinary well in the farmyard or houseyard is almost certain to be tainted : it may have been used for generations without any ill effects, but still the trouble there and may be the unrecognised source of illness or

low vitality to both man and beast. The reason is that in a farmyard there is at least a dunghill, and perhaps cattle and stable yards in addition, and the sewage from these is certain to penetrate downwards to the underground store of water and eventually find its way to the well, though the latter may be fifty yards away. As a matter of common experience the soil beneath a homestead—which probably has been a site for centuries—is saturated with sewage, and, therefore, no surface wells should be used nowadays with such surroundings. Where impervious beds of clay lie near the surface with water-bearing strata beneath, it may be desirable to bore through the top layers to the water beneath, insert a tube to keep out the top water, and pump from below. In some special cases an Artesian well may be bored to a great depth and thus tap the stores below, but such cases are rare and too expensive for ordinary farmers.

Attention may be called, however, to the tube-wells, first brought out in connection with the Abyssinian Expedition of a generation ago. A pipe with a solid sharp point on it is driven down into the ground to any depth up to thirty feet: a pump is screwed on to the top end of this, and if there is any water in the strata below it will get access to the pipe, through holes behind the solid point, and be pumped up. If no water is found, the tube can be pulled up and tried in another place. Small tubes of short lengths can be driven with ordinary heavy wooden mallets, but for the larger sizes a pile-driving erection may be necessary. If the tube is left peramnently it very soon, when in work, sucks up all the fine earth and sand round its bottom "nozzle," and makes a cavity which holds water free of silt. The apparatus is the most convenient affair one can have where only a little water is wanted at a time.

It is important to note the nature of the gathering ground of a water supply. Careful examination will of course always show the true nature of the water, but we know beforehand that water from a field which is likely to be heavily manured, from land lying lower down than a neighbouring homestead or village, or from a well in the yard, is likely to be tainted. In any case tests should be made for both quantity and quality, before any expense is incurred in the form of outlay for waterworks.

Apart from the presence of bacterial contamination, water should not contain more than thirty grains to the gallon of mineral matter in solution, while not more than eight grains can be allowed if the water is to be reckoned "pure." The more solids present the more it is to be looked upon with suspicion, because of the possible danger to health. If, however, the solids are formed by lime in solution, no

exception can be taken to their presence: this will cause the water to be "hard," and give trouble from the deposit in kettles and boilers, but it will be healthy enough.

2. *Supply Data.*—It is customary to allow each inmate some twenty-five gallons per head daily, while for farm purposes one gallon per acre daily is an average rule. As, however, much is required in the case of dairy farms for swilling out sheds, for refrigerating milk, and for the extra drink needed by cows, no hard and fast rule can be fixed other than that the supply should be practically unlimited.

For animals in the fields, where there are no running streams, ponds must be made to retain the surface or ditch water. The most convenient place for such is the corner where four fields come together, so that each could be served from the one pond. Very often, however, the site is determined by other circumstances, such as a natural hollow which can be dammed across, or the convenience of getting the drains or surface water to collect at one spot. As an inch of rainfall represents 22,635 gallons per acre, and the ordinary rainfall runs from, say, 20 to 40 inches per annum, we can see that an ample supply falls on each farm if it could be retained for use. A limited quantity only can be held in a pond, and so dependence must be placed on that which is retained in the strata underground.

In the majority of cases the soil is retentive enough to hold water in a pond, but if not, then the bottom must be puddled with a foot of clay overlaying an inch of lime to keep worms away, and a fence put round to keep the live stock out.

The gangways for the access of the stock to a pond or brook gives a good deal of trouble, and would repay the expenditure of some labour and material on them. Gravel, stones, or clinkers never make a good bottom, and get continually poached up if many animals drink at the spot, while wooden slabs do not last very long. The most satisfactory material in the long run is rough concrete. The stones or broken rubble which would otherwise be laid down are sufficient for the concrete work, and a couple of bags of cement will be enough for making an even bed over the gangway. The site must, of course, be cut out on a long, even slant, down to below the level of the water in summer-time, and it may be necessary to bank the water out temporarily until the bottom part is laid. A bedding of hard, broken rubble must be first put down, and on this a layer of concrete, the surface of which must be left rough to give foothold.

In connection with water for dairy purposes, it is essential to have it as cool as possible. Wells in summer seldom fall below 50° Fahr., while pipes laid at a depth of three feet will have the

water at 57° or 58°. This state of matters cannot very well be remedied, but when the water is wanted for refrigerating purposes, the pipes must be laid as deeply as possible, while water may be made cooler by shooting a ton of ice into the well every week or so during summer—a plan now followed by several in the new milk trade.

3. *Gravitation.*—In a hill country there is generally no trouble in the matter. The rainfall is ample, there are plenty of springs at a high level, or opportunities of damming up a reservoir. By these means gravitation water can be brought in pipes to the homestead and led to where it is required, while there is no likelihood of it being contaminated by sewage.

In the lower country, such as the "plains" in several districts, it may be next to impossible to get a "head" of water to ensure a fall to the homestead, and pumping may have to be resorted to. Generally speaking, the sources of water, if it is near the surface, are known to the people on a farm, but sometimes new sources must be looked for by boring, while "water divining" is not to be scoffed at.

The most desirable arrangement is where there is a spring of good water at the higher side of a farm (without any source of contamination above) that can be led down to the homestead in pipes, with a sufficient "head" to rise by gravitation to the second story of the buildings. In such a case it may be necessary to make a collecting cistern at the top end—which is best built of Portland cement concrete—though a pond or reservoir fenced round to protect it from contamination by live stock will serve.

4. *Pipes.*—The most suitable pipe for the water supply of a homestead—where cheapness, efficiency, and quickness of laying is desirable—is the ordinary galvanised iron kind. The size should be at least one inch internal diameter, while one and a quarter inches is better where a fairly large quantity is used, or it has to be brought a long distance. Much depends on the "head" of water, for a greater pressure will ensure a greater delivery of gallons per minute, and thus the smaller pipe may do. The cost of such piping will run from two to three shillings per yard, including laying it, and cutting and filling the trench.

5. *Water-raising.*—Within recent years wind-power has been adopted largely for water-supply purposes, and the disc wheel with metal vanes—first brought out in America—has become a valuable motor for pumping. The trouble in connection with this method is that a cistern, raised up sufficiently high to give a "head," is necessary to hold the water if it is to be utilised by gravitation through-

out a homestead. Apart from the expense of this, a cistern must be limited in size and will therefore not hold a reserve supply to keep going while the windmill is becalmed. In the case of a pond this contrivance will be of the greatest use. The pond will be kept full and may be enlarged with comparative ease to hold any amount of water.

Where there is a running stream of good quality, a supply can be raised by a hydraulic ram more cheaply and efficiently than by any other means. A ram works automatically night and day, and needs no attention if kept from frost, but of course requires a cistern, as in the case of a windmill. Its action is limited to fifteen times the height of the head of water which drives it, while only a fraction of the water used is raised in the supply pipe—depending on the relative heights of the fall and the delivery.

CHAPTER VI.—CULTIVATING IMPLEMENTS

Having now considered what may be called the fixed or permanent equipments of a farm—which should for the most part be provided by the landlord—we next proceed to a review of the portable or movable machinery required by a tenant to do his work.

As regards field implements we will first take those devoted to cultivation, beginning with the plough, and follow with the others in their natural order.

I.—Plough

The plough is the first and most important of the implements of husbandry, and through all the ages has been taken as the symbol of

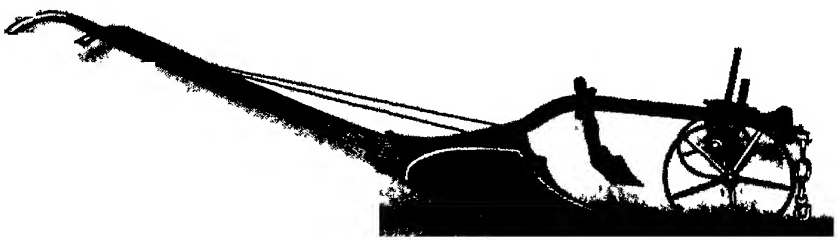

Fig. 6.—Modern Chilled-steel General-purpose Plough with Wheels and Skim-coulter.

farming, while the earliest ploughs known have incorporated in them the same principles as we have in our modern types.

1. *Mechanics.*—Although the plough looks a simple tool, it really contains in its construction the most of the "mechanical powers." Thus the "body" forms a wedge which splits off the furrow slice from the solid land; the mould-board or "wrest" is an inclined plane up which the earth slides as the plough is pulled along; the twist of the mould-board is a screw exactly like the curl of a screw propeller,

while the wheel-and-axle is adopted on all modern wheel ploughs. Lastly, the handles or "stilts" form a lever by which the body is moved and guided, and it is a lever of either the first or second kind according to the way the ploughman moves it. Therefore, it follows that the longer the handles the more power the workman has to control the implement, but for convenience in other respects these are seldom made more than six feet in length and in special cases much shorter.

Formerly, a long sloping mould-board was the fashion, whereby the friction was reduced and the slice turned over unbroken and almost even uncracked, but we now prefer the short, wide-set, concave, chilled-steel mould-board, which thoroughly pulverises and completely inverts the slice and leaves it in a cultivated state, ready, if necessary, for the seed.

A fairly good weight is desirable with a plough, so that it may have enough inertia to withstand jerks and shocks. Modern implements usually run from 200 to 250 lb.

2. *Draught.*—The draught of a plough varies according to the kind of plough, the size of the furrow-slice, and the nature of the soil. It is, of course, very light on a "light" soil, for, as explained in the volume on "Soils," a soil is described as *light* or *heavy*, not according to its specific gravity, but according to the light or heavy draught of the implements required to work it. When tested by a dynamometer the draught ranges from 30 lb. to 100 lb. per inch of depth for a furrow-slice of the ordinary width of nine to ten inches. The limit of two-horse draught work is 6 cwt. per furrow or 3 cwt. per horse, and anything above this would be reckoned "three-horse land." These figures are equivalent to a range of from 5 lb. to 10 lb. per square inch of section of the furrow-slice; ordinary ploughing running at about 8 to 10 lb. in this country.

The chilled-steel form of mould-board has an anti-friction surface, so that the draught exerted by the horses is actually less, notwithstanding its steeper gradient, than that in the case of the long, sloping mould-boards, made either of cast iron or ordinary steel. Thus the breaking up and pulverising of the soil is done with actually less expenditure of power than in the case of the ordinary old long-bodied plough. These modern mould-boards are faced with exceedingly hard-chilled and case-hardened polished steel with a backing of mild tough steel to give them strength; they thus have a surface like glass, which very much reduces the friction and the amount of pull required of the horses.

As the horses have to pull upwards obliquely when yoked to a

plough, there is a certain loss of power; the longer the chains, therefore, the more direct would be the pull, but the practical work requires these to be only moderate in length. A distance of ten feet from the clevis or bridle of the plough to the hook at the horse's shoulder is found to be the best medium, and this will allow the line of draught to be at an angle of 20° with the ground line. Many ploughmen are liable to yoke their horses too near to the plough, and a chain of at least one foot in length between the plough and the whipple-trees is desirable.

3. *Skims.*—A great point with all ploughs is to have them fitted with a skim-coulter. If this is not done then the surface rubbish is not properly covered or buried. Even skilled men, who can make good work without this special coulter, cannot so effectually prevent the growth of vegetation afterwards in the nicks of the furrows, as it is by the use of a large skim and the turning over of an inverted furrow-slice. All modern ploughs, therefore, have now large skim-coulters, and the tendency is to adopt those of the largest size, which pare off the whole width of the top surface of the furrow-slice, and turn it into the bottom of the furrow. It is essential, indeed, that the skim should cut widely instead of deeply, and on this point many makers' examples are deficient.

4. *Wheels.*—For the purpose of doing good work as easily as possible, for both man and horse, all ploughs should be fitted with two wheels on the front beam. These carry the implement at the exact width and depth required, with sufficient flexibility to enable the ploughman to steer straight, and wide or narrow as required. Even three wheels are adopted on the other side of the Atlantic, and the workman sits on the seat and drives the plough like a mowing machine—controlling the depth out and in by levers.

5. *Styles of Ploughing.*—There have been many styles of ploughing practised in past times, but there are only two nowadays reckoned of any moment by those who understand ploughing: The ordinary furrow-slice showing a rectangular section, and the wide "broken" variety. The former is almost compulsory in breaking up grass land for the first time, because a tough sod will not pulverise, and if the work is done neatly and early in winter, so as to get the benefit of the action of the frost, we can get along all right. A slice of ten inches wide and seven inches deep—or in the same proportion—is the best style for this work, as this turns over and fits at an angle of 45°, and at ploughing matches some fine work of this kind is occasionally seen.

For general work, however, such as ploughing stubble, doing

"digging" work, or even subsoiling, the short chilled-steel breast of the digging pattern is the best; it "cultivates" as it ploughs, and takes a wide inverted furrow. This form is gradually coming into use more and more.

High "crested" ploughing, as done in the olden days, was carried out by having a raised "feather" or wing on the share, and thus making "false-bottomed" work, deep at one side and shallow at the other, and showing a trapezoidal section. On grass land this was very liable to grow green again during a mild winter, and is therefore now reckoned inferior.

In a dry country a clean-cut furrow-slice leads to failure of the crop, because there is no foothold for the roots in the open spaces left below. In such districts the inverted, pulverised slice coupled with heavy rolling are the best methods to follow.

6. *Varieties of Ploughs.*—Mention has been made that in some cases a different kind of plough may be desirable for use in ploughing up old grass land as compared with land always under the plough. But there are besides these a large number of different kinds of ploughs in use for various purposes or in different parts of the country. The principal forms of these are the Digging, Double-furrow, Turnwrest or One-way, Disc, Subsoiling, and Ridging.

As already explained, the tendency now is to make all ploughs on the "digging" principle—with short wide-set concave mould-boards which crumple up the furrow-slice and invert it. But specially large varieties which accentuate this feature are made for deep work, and are used in a regular course of cropping on every field in succession to deepen and modify the "staple" of the soil.

Double-furrow ploughs are commendable where the soil is of the lighter class. It is seldom we see more than two-furrow bodies in one frame in this country, because a larger size would be clumsy and not handy in our small fields, but on loamy soil three horses will pull a double-furrow quite easily—yoked abreast—and one man can handle the lot. This saves a man and a horse, or is equivalent to one man doing double work. The double-furrow ploughs now in the market are exceedingly light and handy, and light land farmers are well advised to adopt them.

The Turnwrest or One-way plough is found in many forms. Its object is to plough backwards and forwards in one furrow, so as always to throw the soil to one side. By this means all trouble about "opening up" a field into ridges with crowns and open furrows—and all the labour and trouble pertaining thereto—is done away with, and no open furrows are left at all. It is a convenient

tool for sides of hills where the furrow-slice can always be turned downhill, while if open furrows must be made for surface drainage they can be drawn afterwards.

The Disc plough has in recent years been introduced into this country. It is practically a large saucer-shaped disc of steel which—set at an angle—scoops out a slice of earth and acts like a digging plough. This is the favourite form in the United States. Its drawback is that it is liable to be heavy and clumsy, and as it is never provided with a skim-coulter it leaves the vegetation not properly covered in.

The work of the Subsoil plough was explained in the volume on "Soils," so that it is here only necessary to say that this implement, like the others, takes many forms. Sometimes it may be a huge hinged tine fastened to the beam of a common plough in front (as illustrated in the volume on "Soils"), so as to rip up the bottom of the furrow. Sometimes it may be a mould-board which ploughs up the bottom of the furrow behind or in front of the body proper, while this turns an ordinary furrow-slice: or it may be a separate plough altogether, ripping up the subsoil in front or behind a common plough. As the object is to stir up the ground below the ordinary top soil without bringing it to the top, perhaps the tine ripping along in the front of a common plough body in the same frame is the handiest form.

For forming ridges or balks for roots, the Ridging or Double-Mould-board plough is used. This is simply a plough frame with two side wings, which, in passing through soil previously loosened by cultivation, brush it up into ridges coming and going, and leave these ready for root growing. Improved forms of this plough, with double wheels in front, are now in the market. More recently the ordinary cultivators have removable tines, so that two or three moulding bodies can be affixed in the frame and a coresponding number of drills or ridges made at one passage of the implement.

II.—Harrow

The harrow has been developed for the purpose of smoothing the soil after ploughing, or other cultivation, to cover in the seed, and to make a surface tilth. There is a long series of implements with a harrow at one end and a cultivator at the other, the many intermediate forms of which tend to the nature of one or the other, but all are intended to stir up the soil, pulverise and mix and smooth the surface.

1. *Varieties.*—There are many varieties of the harrow proper, of

which the principal kinds may be classified as follows:—Bush, Chain, Zigzag, Grass, Drag, Spring-tooth, Disc, Knife, and Drill.

The Bush harrow is the original form and the simplest of all, being merely a bunch of tree boughs or thorns fastened to a frame and used for brushing over a meadow in spring to spread worm-casts and smooth the surface. Sometimes it may be used for covering small seeds.

The Chain harrow is an iron or steel substitute for the Bush. It does the same kind of work as the latter, but much more efficiently. This harrow is especially useful for breaking down and spreading evenly any top-dressings of dung or compost, levelling mole-hills, etc. The plain square link form is the best of all, for some of the complicated forms do not wear very well, while they are liable to clog when in work. A scraper can be fixed on the fore part of the chain which will raise and break up any hard lumps of dung or earth, and thus adds much to the efficiency of the implement.

The Zigzag harrow is the common standard form, so called because of the arrangement of the frame. This was designed in order to give strength combined with lightness, and at the same time to carry the teeth or tines so that each should follow a tract of its own when in work. The frame should always be of angle or channel iron, while in the more recent forms the teeth are fixed to movable ribs controlled by handles in order that they can be tilted to suit the kind of work required.

The Drag harrow is one of a larger and heavier make with the points of the tines curved forward, so that it can take a good deep hold of the soil, and thus really act as a cultivator and stirrer rather than for merely smoothing the surface. There are many varieties of this form, some with broadened-out points ("duckfeet") which act as shares for cutting underneath, some carried on wheels, and so on.

From the other side of the Atlantic has come the Spring-tooth variety of harrow, of which there are two kinds;—one where each tine is a spring itself, and one where ordinary straight tines are fixed in a frame and the whole balanced against one large spiral spring. The latter form is the best, but the good point about both is that they are adjustable, and that the teeth vibrate and "give" a little when they strike an obstruction in work (see volume on "Soils," p. 95).

The Disc harrow is another transatlantic importation into this country. It consists of a framework of sixteen steel plate discs each sixteen inches in diameter, and revolving at a slight angle to the

direction of travel. This is particularly useful in cutting up turfy lea furrows to make a surface tilth, and was originally invented for breaking in new prairie soil. The "Acme" or Knife harrow does the same work, and may be recommended for use where grass land is regularly broken up, and where the tough, turfy furrows do not easily break down with the ordinary harrows.

The Drill or Ridge harrow is used in root cultivation for harrowing the spaces between the rows of the crop, and is an adjunct or supplementary implement to the horse-hoe. Its use is to follow the latter implement and shake the weeds up to the surface and level the mould after the passage of the other. There are various forms of this harrow, but the principal ones are those for plain harrowing between the ridges, and the "saddle-harrow," made to lap over the top of a ridge, whereby it can be harrowed right into the roots of the plants. Both kinds are made to be guided by handles and have the framework adjustable to set them as accurately as possible to the work required.

2. *Construction.*—All harrow frames should be made of angle or channel iron to give great strength in proportion to weight of metal, and the frame should be braced with diagonal struts in some part of its construction. The "zigzag" frame was introduced partly because it is self-bracing. The teeth, or tines, should be fixed in such a position that in work each will draw a separate line in the soil from the others. The fastening of each tine to the frame should be wide and thick and strong to resist the shocks while at work, for it is at this point a weakness will show itself, and advanced makers have special varieties of shackles or other contrivances to meet the case. The ordinary narrow neck with a nut screwed on is very liable to break.

Harrows are usually made eight feet wide, and with at least two leaves to be adjustable to the inequalities of the ground. The most modern forms run on wheels and have adjusting handles by which the points can be set forwards or backwards according to the work to be done; this is one of the best forms of harrow to have for general purposes.

A more recent improvement is to provide the implement with a seat, whereby the driver can keep his horses going smartly without tiring himself, and at the same time easily control the handles. A further development is a "harrow-cart," or seat fixed on a separate wheeled frame, which can be attached to any set of harrows. This latter is another American invention which is better than the fixed seat, because it can be fitted to any harrow.

III.—Roller

This implement is used for two purposes—to compress and smooth the soil and to break the clods. There are two kinds of these—the smooth-barrelled and the ribbed or toothed, and of each of these there is a never-ending number of varieties.

The one great principle to be attended to in selecting a roller is to procure one with the largest diameter of barrel possible. It is demonstrable on ordinary mechanical principles that the larger a wheel is the more easily it is turned, because the spokes act as so many levers. In the case of rollers a medium diameter of thirty to thirty-six inches is desirable, as this size does not entail the making of the metal-work too massive, while the draught is so much more easy than in the case of a small drum roller. The examples of rollers of from one to one and a half feet in diameter are most undesirable, and are not used by people who understand these matters.

In modern examples the drums are made of boiler-plate of one-fourth to three-eighths of an inch in thickness, and rivetted on to light framework so that we get the easy draught without too much weight.

Rollers of the heavy toothed (Crosskill) or ribbed (Cambridge) type are used as clod crushers to pulverise the soil or to roll firmly without leaving the top too smooth, and are made up to two feet in diameter. With such two horses are necessary, yoked abreast, and it is desirable to have a pole between them and the yoking done as in a mowing machine. As explained in the volume on "Soils," the use of a ribbed roller in a dry district is especially beneficial, because, while compressing the soil to promote capillarity, the "ribs" of loose soil left between the flutings act as a wind break and a mulch, and prevent too much evaporation. Harrowing lightly after rolling is therefore good policy in a dry district or in a dry season. For general purposes the ribbed form is much better than the toothed variety.

Another advantage to rollers is to have a seat in the form of a plank reaching from end to end, and above the back part of the frame of the implement. This gives the driver much better control of the horses, enables him to change from end to end when turning at the headlands, and in driving he can see straight down the line of the work.

Rollers are from six feet wide for single-horse light varieties, up to eight feet wide for heavy two-horse implements. They run in weight from 10 cwt. to 20 cwt., but the weight can always be increased by tying a log or two across the top, or fixing a box to hold

stones. In an ordinary roller the drum is always divided into two or sometimes three pieces, for the purpose of facilitating turning at the headlands.

IV.—Cultivator

The work done by the ordinary cultivator, and the best kinds to use, as well as its influence in producing an amelioration of the texture and tilth of the soil, has been partly detailed in the volume on "Soils," but some further information on the make of the implement is necessary.

As explained before, a drag-harrow, or even a harrow on wheels, might be classified as a cultivator, where the action is to stir up the soil more than to smooth the surface and cover in seed. The cultivator proper is built to take a width of, say, five feet at a time, to require about three horses to pull it, and the tines are set to go down to the usual depth of ploughing. There are now several good forms of this implement on the market, but the points to look at are that the tines themselves have rigid stalks, and a spring setting of some sort. Spring-tooth cultivators have been a failure, as they only scarify, but a rigid stalk working against a spring has been a great success. It "bites" deep enough into the soil, the spring "gives" a little if some extra obstruction is encountered, while the continual vibration of the whole helps the stirring action and shakes the stalks free of weeds or rubbish.

Some other points about a good cultivator may be enumerated. The tines should be flat ribs set edgeways to the work, so as to give the greatest strength of material, and at the same time the least resistance to the soil. It is usual to allow three to every horse, though a seven-tine cultivator may sometimes be handled by two horses.

There is a vast number of kinds of shares that may be had for different kinds of work, from a narrow ripping one to a broad, thistle-spudding size. All of these, however, should have sharp cutting edges, for one of the greatest improvements of modern times is to make the shares of sheet steel with a knife edge. In the old days these were made of cast iron, or malleable iron "laid" from time to time by the blacksmith, and the edges were as thick as the sole of one's boot; thus the adoption of sharp steel shares has been a great advance.

It is now customary to have high wheels—not less than three feet in diameter—as thereby the cultivator runs more steadily, though, of course, the front wheel must be smaller.

The modern cultivator is a combined tool. Besides doing ordinary cultivating work the tines can be set for horse-hoeing or cultivation work between the ridges or balks of roots, while, as noted before, moulding-up bodies can be substituted and this work done at the rate of one body for each horse pulling the implement, though three horses to two bodies work together much better. When ridging, the whole must be guided by two handles, and these ought to be fairly long to enable the workman to guide it easily. When not ridging up the man can drive from a seat and control the whole.

V.—Horse-hoe

The cultivation of the crops after they have sprouted, and are growing and gradually covering the ground, involves the use of many varieties of cultivators, specifically known as horse-hoes. In some parts of the country the corn and bean crops are all cultivated when growing, and for this purpose the seed is drilled in even rows. In some districts, again, to still further expedite true and even work, the land is laid up in narrow ridges or "stetches" with furrows between, in which the horses walk. The horse-hoe is adapted to the width of these, and the hoe blades are set to suit the rows of crop and are thus worked between the rows of corn very accurately.

Horse-hoes, however, are more generally used in the cultivation of root crops. These are almost invariably grown in rows from twenty-six to thirty inches apart (either on a ridge or on the flat) and require a vast amount of horse cultivation between the rows. A one-row cultivation has therefore been in use from old times, while nowadays we have combined forms which take from two to three rows' width at once, and work with one horse. Almost every implement maker has his own pattern of these, and it is impossible to recommend any particular maker, but certain rules may be advantageously followed. Horse-hoes should have interchangeable shares or points so that any particular kind may be fitted on: these shares should be made of sharp sheet steel in order that they may cut the weeds and the soil as easily as possible. The framework should be firmly bolted together and not be loose and shaky, while at the same time allowing of adjustment.

The V-shaped shares are the best for all-round purposes, and the L-shaped ones should never be used, as they are liable to tear through the roots next the plants too much. The V-shares can be had from three inches to twenty-four inches wide, the latter taking the whole width between the rows in one lot, and thus missing nothing.

Hoes of the above description have steerage or guiding handles to keep the shares easily in the line of the plants if the horses or the machine tend to run off the straight at any part. It is essential that this guiding or steerage should work easily. There are many makes in the market of exceedingly clumsy construction and difficult and heavy to handle or guide. Consequently the would-be purchaser must exercise great judgment and caution in procuring one.

Horse-hoes are used because harrows do not go deep enough, and do not cut and uproot the weeds, but it is often a good plan to follow the hoe with the harrow. As explained before, there are several varieties of harrows for dealing with root crops grown in drill-rows or balks.

VI.—Hand-hoe

There is unfortunately a great deal of hand work necessary in the cultivation of root and other crops, and consequently the hoe with which this sort of work is done must be discussed with the other implements of husbandry.

In some districts the hand-hoeing of corn and other crops is still carried on, and, under such conditions; the work is done by long sweeps of the hoe. A man can reach forward and draw his tool towards him over a good many feet of ground every stroke, and probably cover half an acre per day. For such the blade of the hoe may be set at an acute angle to the shaft, to ensure its cutting through the soil at, say, an inch depth or so. Though the same work could be done with a horse-hoe or even a harrow at a much cheaper rate, undoubtedly the hand work gives better results.

Unfortunately, the same style of hoe is used in many districts for setting out and dressing roots, with the consequence that the job is botched and the crop materially injured. There are many thousands of workmen who have been hoeing roots for a lifetime and yet do not know, and cannot be taught, how to do the work properly. It is essential for this work that the blade of the hoe be set square to the handle, and that the singling out and other hoeing be done by a "push-and-pull" *across* the line of roots. If anyone will watch the ordinary workman with the other kind of hoe cutting up and endeavouring to "set out" the plants by chopping at them *up and down* the row, he will see how difficult it is to "single" them out in this way, and how liable men are to cut the whole away and leave a gap. Those accustomed only to the use of this latter form do not see its defects, but to a north countryman coming from a district where

only right-angle bladed hoes are used the work done by the other is glaringly deficient and injurious to the crop yield.

Hoes are made with blades from five inches to eight inches wide, but a good working size is six inches. The blade may sometimes be fixed to the shaft by a "swan-neck" stalk; this is undoubtedly a benefit for flat-hoeing where weeds or surface rubbish are troublesome, but is not so necessary for the square-set blade used for root hoeing, because the latter must be firmly attached to the handle without springiness.

By the use of the last-named hoe a man could single out an acre of roots in from twenty to thirty hours where the rows are about twenty-seven inches apart and the roots ten inches to twelve inches in the rows. If the land is very stiff or foul more time would, of course, be required, and many men with the other hoe require forty hours to do the work.

Hand-hoeing root crops is very materially reduced and made easier by the use of the disc side-scarifier and the thinning machine. The first consists of a frame on two concave rollers which run on the ridges, and behind which are two pairs of revolving discs which cut and pare away the soil—carrying the weeds with it—from the sides of the rows of plants on the ridges. This is to take the place of the "side-hoeing" by hand, and materially eases the work of singling out. After this follows the thinner, which carries a revolving series of blades that cut *across* the line of the rows, and chop out gaps according to the setting, leaving bunches of plants at regular intervals. These can then be "singled" by hand or hand-hoe, and thus the whole of the manual labour is reduced to this last operation.

In these days of careless work, these machines which reduce the manual labour and clean and set out a crop with mechanical precision are an immense advantage. Each is, of course, drawn by one horse in shafts and handled by one man. The thinner is carried on a spring frame, so that when a part deficient in plants is encountered the workman holds up the blades till it is passed.

CHAPTER VII.—SEEDING AND MANURING IMPLEMENTS

A WHOLE series of implements have been introduced in comparatively recent times for distributing the seed and manure over the fields—work which used to be wholly done by hand, and still is in some districts. Almost every kind of seed or manure requires special machinery to handle it, but in recent times the tendency is to "combine" these so that one implement will do as many jobs as possible. The principal examples of this kind of machinery are the Corn-drill, Broadcast Seeder, Mangold and Turnip Seed-drill, Manure Distributor and Dung Spreader.

I.—Corn drill

In the older times, and even yet in many cases, the seed was broadcasted by hand and then harrowed and covered in. About the middle of the eighteenth century Jethro Tull taught the value of drilling seed in straight rows ("drill husbandry") so as to facilitate horse-hoeing and cultivation. He practically invented the corn-drill. So slowly do some minds develop, however, that the corn-drill remained much as he left it for nearly a century and a half, and it is only within our own times that there have been any attempts at improvements, and these have for the greater part originated across the Atlantic.

1. *Arrangement of Parts.*—The principle of the corn-drill is a hopper carried on wheels: in it revolves a seed-distributing barrel which passes the seed in regular quantities down a series of funnels to the coulters. These latter are arranged to cut into and divide the soil to a depth suitable to the kind of crop being sown (say two inches for corn, and half an inch for clover seed) and drop the seed in the rut thus made, to be covered up afterwards by harrowing. The width of the implement between the driving wheels may be anything between five feet and ten feet, but seven feet to eight feet is the common allowance for a two-horse implement. The "seed barrel" is best made on the "force-feed" principle, in which a series of bowl-wheels revolve inside their respective cases and carry round and "force"

out the seed in proportion to the speed of revolution. This is much better than the "cup-feed," in which a series of small spoons fitted on the barrels dip into the seed in the hopper and spoon it out—the objection being the irregularity of delivery. The seed thus delivered passes down spouts or funnels, and it is found that the telescoping tin funnels are very objectionable, for the manure, which ought to be delivered down the same spout, rusts them out very quickly. Coiled steel-ribbon funnels are better than tin spouts for grain only, but indiarubber tubing is the best of all : it is flexible and is not acted on by either the weather or chemical manures.

2. *Coulters.*—There are four styles of coulters in use for cutting into the soil : the hoe, the round-nose, the shoe, and the disc. The hoe form is the worst kind, and can only be used on clean land in a very fine state of tilth. Therefore it should never be adopted for general purposes. The round-nosed is the one commonly found on drills of English make, and is as inefficient and antiquated as round bowed ships in these days when long sloping bows are the rule. The shoe form is the long sloping kind, which slides through the soil and over any vegetable rubbish without clogging and with the least friction. The best form of all, however, is the disc-coulter of American invention, in which a revolving, circular steel plate—set at a slight angle—cuts a channel in the soil, and through any rubbish, in which the seed is deposited. This form reduces the friction very much, and at the same time runs without choking, as it cuts its way along. The satisfactory use of the revolving disc—already explained in connection with other implements—is found to extend to the corn-drill. The discs are of course fitted with scrapers to help them to run clean in damp soil, and the single-disc form is better than the double-disc. A presser behind forces the coulters into the ground, but each coulter has a controlling spring which allows it to accommodate itself to the inequalities of the surface : this is a much better arrangement than the old style of one unyielding uniform pressure given by an iron bar fixed along on top of the coulter-stalks.

The number of coulters in a drill is a matter of some importance. As various crops require to be drilled in at different widths, it is essential to have the number and arrangements to suit the removal of various alternate rows. For this reason thirteen coulters is the best number, because thirteen is divisible by six, four, and three, leaving the two outside ones untouched. Eleven coulters will divide by five and by two, but thirteen is better, while it is better still to be able to move them to any point along the hinge-bar. It is also sometimes desirable to have the funnels so fitted as to catch the seed

from two or three of the bowl-wheels and convey it down into one spout.

Where ordinary work is being done, two horses yoked with a pole between is the best method with these modern drills, but where regular straight rows are required a steerage must be fitted on to the implement between the carriage and the horses. The single central wheel steerage is the best, for the double-wheel variety supplied with some makes is clumsy and difficult to guide.

3. *Combined Form.*—Several combinations of the greatest value in the matter of saving labour are made with the modern corn-drill.

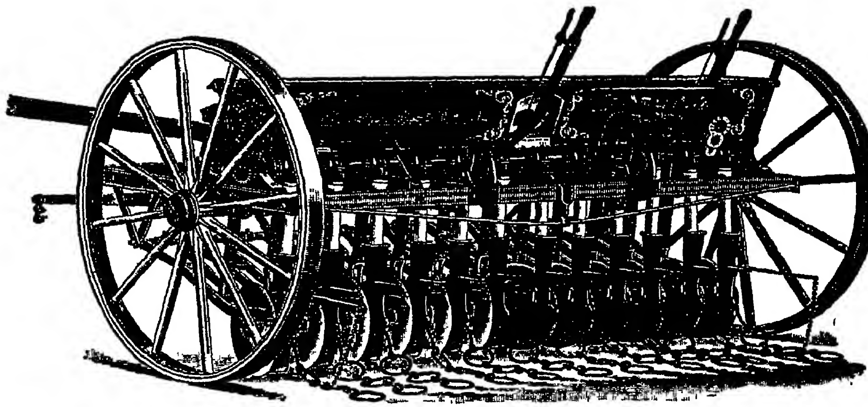

FIG. 7.—DISC CORN-DRILL.

Thus an arrangement of hopper and distributor for sowing artificial manures is fitted on, whereby the manure goes down the same funnels as the seed, and is deposited along with it. Then, again, the fixing on of two seats, one behind each wheel, enables one man to drive the horses and look after the coulters as well, and thus control the whole machine, instead of requiring the usual complement of two or three men.

The latest form of seed-drill has a grass seed-sower fitted in front and a light chain harrow behind (see Fig. 7), so that four operations can be conducted at once, and all worked by one man and two or three horses. Usually, however, it is not necessary to do more than sow, say, corn and manure at once, and a second man expedites matters.

The disc-coulter has been so successful in practical use that many British makers have now adapted it to home-made drills.

II.—Broadcaster

While drill husbandry has long been established as an accredited system, the practice of broadcasting the seed has still continued, and machines for this purpose have been developed and are in common use. A drill can be used as a broadcaster by taking off the coulters and allowing the seed to drop loose on the soil, while the distributing wheels or other apparatus on the broadcaster must measure out the seed as evenly as in the case of a drill. Land must be very accurately ploughed for broadcasting purposes, however, and left with a sharp crest and a deep "nick" to every furrow slice, so that the seed may be deposited regularly. Indeed, the "Wheel-presser" may have to be used beforehand. This implement consists of some three heavy cast-iron wheels or rings fixed in a frame, which is run over the ploughed land so that each "wheel" presses a furrow "nick," and thus makes it an even bed for the seed. Broadcasting, again, cannot be done behind the modern digging plough, because there is not enough cover left for the seed Furthur, broadcasting does not suit dry districts, but only wet ones.

Broadcasters are of two kinds: those that are provided with a hopper from ten to eighteen feet long, and take this width every time, and those provided with revolving discs on which the seed is dropped and thrown widely. The latter is in use in America, but the former is better liked here, because it deposits the seed more regularly, for the revolving discs depend on the speed of the horse that pulls the machine for even distribution.

There are the same distributing arrangements as on the corn-drill, and the seed is simply allowed to fall loose on the ploughed land before harrowing. As there are no coulters to pull through the soil, one horse in shafts can work the lot.

The barrow-seeders—referred to in the volume on "Crops," p. 69—are of the same type, and are immensely useful for sowing grass, clover, mustard, and other small seeds that must be broadcasted. As these take from twelve feet to fifteen feet wide, and can be wheeled by one man, the work is very easily and expeditiously got over.

III.—Mangold and Turnip Seed-drill

This is a form of seed-drill that calls for comment, partly because it is an implement that is quite unknown in some parts of the country, and partly because no maker has yet brought out a good specimen of the combined form of tool. It is intended to sow the

seed on ridges or balks in contradistinction to drilling on the flat —a practice which obtains in dry districts—and several points ought to be attended to in designing a suitable implement. The foundation of the whole is a pair of concave rollers which run on two ridges at a time, with the horse in the shafts between. The rollers should be toothed on the Crosskill principle so as to break the clods, and thus prepare the balk for the easy passage of the coulter behind and the covering of the seed with fine crumbly soil. These rollers should be a good size, and be adjustable to running on ridges from twenty-five inches to thirty inches wide.

On the top two seed boxes are fixed with revolving spindle for delivery, and with funnels carrying the seed down to the two coulters.

The best seed delivery is through a brass plate with a series of holes of a size suitable to the amounts of seed to be deposited per acre, and through which the seed is stirred by a star-wheel revolving in the seed hopper. In the funnel through which the seed is carried there must be an opening that the seed can be seen running down when sowing. The coulters should be of the long sloping shoe type so as to cut clean, and the handles which control them should be rigid and strong. No implement known to the author comes up to all these qualifications, but any maker who will endeavour to combine them into one will command the market.

The small rollers for pressing the top of the ridges behind the coulters are of no use whatever: the seed ought to be covered sufficiently without them, and if rolling is needed—as it is in a dry district—the ordinary heavy horse-roller should be used.

IV.—Manure Distributor

Ever since the introduction of artificial manures—say over half a century ago—there has been great need for the invention of machines to distribute these equally over the soil, and we cannot say that we have reached perfection, or even efficiency yet. What is required is, of course, a machine which will distribute with perfect regularity from a half cwt. to say ten cwt. per acre of all sorts of compounds—mostly in the dry, powdery form, but some of them of rougher material, and sometimes slightly damp, as in the case of superphosphate.

All the various makes of distributors may be classed under, say, two heads, drill and broadcast, while there are two kinds of broadcasters—the ordinary wide-dropping feed, and the blowing or spin-

ning kind. Those makes which can be used either as broadcasters or for sowing in rows or drills are the best, as we require to do both ways in ordinary work. Wallace's distributor is one of the best for this purpose: the manure falls on to revolving discs which scatter it from twelve feet to twenty feet wide, according to the kind of stuff, or by removing these discs it falls down two spouts into rows to suit root crops. An implement for combining the opening of the ridges for roots and sowing of the manure at the same time is coming into use in the north, and is a great labour saver: the ridging bodies are fixed in front, and the manure is dropped behind as they pass along.

For corn crops the combined seed- and manure-drill, described above, is the best, as the manure passes down the same funnels as the seed, and is deposited along with it, while by removing the coulters it becomes a broadcast machine of its own width.

The arrangements for feeding the manure are defective in most cases, and we have not yet got what we want. It is better to regulate the feed by the speed of the gearing, and not by the size of the openings through which the manure passes, as more equal distribution can thus be attained. It is desirable also that a steady horse should work an implement of this kind: a fast walker is apt to throw out the manure too fast proportionally, and conversely with a slow animal.

Each machine must have a stirrer of some sort, as artificial manures of all kinds are apt to get "set" and cave over the outlets, hence the stuff must be kept moving continuously by some mechanical arrangement.

V.—Dung Spreader

One of the latest developments of labour-saving implements is that for carting out and spreading dung. Perhaps the reason this development lagged behind the others is the fact that dung-carting and spreading is mostly done in the winter time when other work is slack and labour is at its cheapest. This implement has therefore very naturally been invented in America, and its use is rapidly extending there. It was introduced some time ago into this country, however, and is now made here. The principle is simply that of a two-horse waggon with a travelling or revolving bottom, on to the hinder part of which is fitted a revolving framework carrying teeth. The moving bottom carries the load of dung against the revolving framework of teeth and by these is scattered out behind in any

desired quantity. The toothed "drum" is usually made of eight bars or ribs, and the pegs in them are placed so that each cuts a line of its own as it revolves.

The great point about this mechanical spreading is its evenness, besides its saving of labour. By this method it is only necessary to load up the waggon with the manure, drive out to the field, and the machinery does the rest; there is no waste of time and labour putting the dung out of the cart into heaps and then spreading these by hand-fork; indeed, the spreading is done as fast as five men could do by hand.

The superior fineness and division of the dung and the evenness of the spreading are greatly in favour of this method, as it makes the dung go further and gives better returns in the crop. The distribution may be made so fine that it could be put on as a top-dressing to a growing crop. Again, by fixing a shield behind the beaters with openings, the dung can be dropped into the ridges or balks for covering up for root growing.

The drawbacks are that a dung-spreading waggon costs a lot of money; two or even three would be required to tackle the dung on a fair-sized farm, and it is only in use for a comparatively short time in the year, and takes up a lot of shed room in the homestead when not in work. It cannot conveniently take the place of carts for haulage, though when the beater is removed and the hind door shut down it does well for carrying potatoes, coals, sacks of grain, or any other heavy stuff. By turning the bottom with a handle the load can be very easily emptied out gradually behind.

CHAPTER VIII.—HAYMAKING IMPLEMENTS

Haymaking has been revolutionised during the last twenty to thirty years, and is not now the frightfully laborious work of the olden time. The scythe, the hand-rake and the pitching fork have largely given way to horse-propelled machinery, and this in turn is rapidly being replaced by motor-power.

The most important implements which we must notice on account of their labour-saving value are the Mower, the Swathe-turner, the Horse-rake, the Rick-lifter, the Horse-fork, the Sweep-rake, and the Elevator.

I.—Mowing Machine

The reaping and mowing machines were combined in one in the early days, interchangeable cutting parts with gearing to correspond being fitted on to the same carriage or truck. Invention, indeed, was first devoted to the making of a reaper for cutting the corn crops, and the first workable machine brought out in this country (by the Rev. Patrick Bell, of Carmylie, Forfarshire, in 1826) was for cutting oats. The adaptation for the mowing of hay was a subsequent development, and now in our days, since the general use of the string-binder for corn, the mower has been developed for grass cutting alone.

The majority of mowers made now have all modern improvements, but there are some few in the market that still keep to the unimproved forms, and it is presumable that there are still farmers who believe in these and buy them.

1. *Size.*—The first point to be attended to in selecting a mower is to choose one of the largest size: the widest truck and the highest wheels are desirable, because they give strength and steadiness, and make the wheels "bite" better with less tendency to skid. In former days the mowers were made too small and light and gave much trouble in this direction, but now the making of larger machines is the rule.

The next point is to have a long cutting bar so as to take as wide a swathe as possible. In the early machines a swathe of three feet wide

was quite enough for two horses to pull, but the adoption of roller and ball bearings, and the gradual perfection of all the parts, has made it now possible for two horses to cut a swathe up to eight feet wide. This width, however, is too much for ordinary work, and can only be adopted on very smooth meadows where there are no furrows or natural inequalities. As a rule, five to six feet is the most convenient width for ordinary purposes, and is quite wide enough for the after work of other haymaking implements, such as the swathe-turner and the horse-rake.

2. *Desirable Points.*—The desirable points about a mower may be enumerated as follows:—

The pole should be as long as possible to counteract the side pull of the cutting bar, and the horse placed on the opposite side of the pole from the growing crop should have surcingle and martingale belts as part of its harness to meet this pull.

The whipple-trees should be fixed *below* the pole, so as to carry the weight by the pull of the draught chains and not by the collars of the horses.

The attachment of the whipple-trees should be by a spring arrangement in order to ease shocks in draught; indeed a spiral spring in all draught arrangements is an advantage.

The connecting rod or pitman should be as long as possible to ease the force necessary to drive the knife by allowing of more direct action. It should be made of wood, as the continual jarring tends to crystallise or alter the molecular structure of the iron and make it more brittle. From this cause iron rods often break. There should be a high rate of revolution of the crank to the carriage (driving) wheels for grass-cutting purposes, one to thirty-three being very common.

The knife bar should have adjustable fittings that it may be kept in perfect alignment with the rest of the machine, *i.e.* at right angles to the crank shaft and to the line of travelling. It should be fitted with foot-trip to lift over obstructions, and the farther it can be lifted while in work the better. The latch or fastening which keeps the knife in place should be made on a simple plan to facilitate removal for sharpening and replacing.

The ends of the knifeboard may be carried on sliding shoes instead of wheels. Theoretically, wheels would run the easier of the two, but there would be little difference in practice in such small compass while, on the other hand, the wheels in these parts always wear out very quickly. Against the wheels, again, is the fact that they are more liable than sliding shoes to drop into hollows in the ground.

3. *Wearing Part.*—The swathe-board is the first part of a mower

to wear out, for no one has yet devised a fitting for fastening this to the outer end of the knife-board that will wear for long and keep the board sliding along at the proper angle. There is room for invention yet in this matter. The inclusion of a spring in the joint of the board allows it to accommodate itself better to obstructions and inequalities.

For sharpening the cutting blades or sections nothing has yet been found to beat the common hand file. The various small emery stones on the market seldom give satisfaction, and grinding on an ordinary grindstone is very little better. It is essential, of course, that the knives be kept sharp—more so with mowers than with reapers—that they fit well to the finger plates, and that the "travel" should fit exactly to the finger spaces.

The mower has almost rendered the scythe an obsolete implement, and the latter is only reserved now for cutting irregular land, banks, and corners where the mower cannot work. The latter makes a much more regular, even job than ever was done by hand-mowing, apart from the question of labour, in which there has also been a great advance. The ground could be "shaved" now by the modern machines, but it is not desirable to cut too closely. If the grass is bared in to the very roots and a drought follows, the next growth would be injured; therefore a certain amount of stubble should be left.

II.—Swathe-turner

This is one of the modern developments of haymaking machinery, by which the hay is turned over by one man and a horse as quickly as—and in a much better manner than—half a dozen men with hand-rakes did it in former times. The first implements in this line were invented nearly half a century ago, but it was not until our time that the "tedder" first and the "kicker" afterwards was brought out, to be followed by the swathe-turner. The objections to the former implements are that they break the stalks of hay too much and knock off the leaves—a serious drawback in handling clover or lucerne—while at the same time their draught is very heavy. On the other hand, the swathe-turner works much more easily and gently, and—as its name implies—turns over the swathes partly upside down and partly sets them up on edge to let the wind blow through them. The speed should not be too great, for actual test has shown that hay turned over gently and left opened up dries more quickly than that which has been tossed over rapidly and left lying flat and lodged.

A properly designed swathe-turner should be made to either turn the two swathes separately, or to turn them in to one wind-row. When so constructed it can then be used for simple turning, for drying purposes, or two swathes can be turned on to a third—thus in going up and down, five may be put into one—and make a large, loose wind-row ready for cocking or stacking. The implement should be further designed to have the changes of motion made by merely setting suitable handles, and not by unscrewing and refitting the parts.

III.—Horse-rake

Next to the mowing machine the horse-rake is the most labour-saving implement, and its invention followed as a natural result of the use of the mower. So long as the mowing was done by the scythe the common hand-rake was sufficient, but a horse-driven implement in one direction necessitated a horse-driven one in another.

The horse-rake is one of the few implements which we make better in Britain than is done in America. The designs employed across the Atlantic have been too light and gimcrack for our purposes, and though no doubt thousands of these are in use in this country, yet the ground is not raked with them as clean as we desire. This is due to the fact that, while made of the best material, the foreign design has the teeth of so slim and springy a type that they dance about too much and thus the stuff flitters through, and the work is done inefficiently. For pulling the hay into wind-rows, or raking up long stuff, they do very well, but not for the final clean raking of ordinary short hay.

For efficient work a heavy stiff tooth with a T or H cross section is required, but the tipping adjustment must be one of perfect balance and easily handled. Some users believe in a self-tipping ratchet arrangement whereby a simple touch of a foot lever locks the frame, and the forward motion of the driving wheels tips the teeth and empties the load. Many, however, prefer the manual tipping arrangement as being surer and more perfect in work, while in a properly constructed rake the working by hand is very easy indeed. Some rakes are very heavy, and a purchaser must see to it that he selects one of the good sort.

A general fault of horse-rakes is that the comb or framework for holding down the stuff when the teeth are lifted is too low. It wants to be low so as to clear the teeth, but there is also required an upward extension in order that the teeth will be kept in their places

when elevated to the highest, and it is this upward series of iron bows which are never high enough. An extra short side tooth to keep the stuff out of the wheel is also desirable, and the wheel should be of the largest possible diameter with staggered spokes for side strength.

The standard width between the teeth is three inches, probably adopted in imitation of the old hand-rakes, but abroad the horse-rakes are sometimes fitted up to five inches wide. They must be made adjustable, so that the points may be set to suit the particular work required as regards height, and their forward or backward position. The fixing of the wheels to the frame is an important point, and those rakes have an advantage where there is a solid "through" axle.

The side-delivery rake is designed to comb the hay *across* the line of draught, and deposit it in a side wind-row, and by going up and down two sides and throwing in to one centre, a light, airy wind-row is very quickly made, but this variety is apt to break off and loose the leaves and short stems, while it cannot rake the ground clean afterwards. Its special value is to make wind-rows quickly for the after use of the hay-loader or for cocking purposes.

The ordinary horse-rake takes a width of about eight feet, or say, two swathes wide, but rakes reaching up to sixteen and even twenty feet wide are in use. One horse can conveniently pull up to twelve feet wide, but beyond that, in our heavy crops and damp climate, two horses yoked with central pole would be necessary. A wide rake, it must be remembered, does not work well on an uneven meadow or a field laid up in ridges or stetches, because of the side swing or jolt in crossing hollows, and therefore the ordinary one-horse size is usually the best for all-round purposes.

IV.—Sweep-rake

This labour-saving implement is of American origin, and was first adapted to work in this country in 1894 by the author of this hand-book. It took him two years of experiment and development to get it to handle an English crop satisfactorily, but it is now a recognised adjunct of the hay field, and many thousands with many different modifications introduced by different makers are now in use in the south of England. As will be seen from the Frontispiece, the principle of the implement is a large frame running on two end wheels, with a rear swivel wheel. On the ground a series of iron-pointed, wooden tines, some ten feet long, slide along over the

ground. Two horses are yoked, one at each outer side of the framework, and controlled by a man sitting on the seat behind. When in work the horses are driven up and down the rows of haycocks, and the implement scoops these up as it passes along. When a full load is obtained it is drawn to the stack and unloaded by simply backing the horses out. The hay loads up best out of the cock or quile, but it can also be collected out of the wind-row or even out of the swathe. A load is from two-thirds to a whole of an ordinary field cart-load, depending on the nature and condition of the hay, and whether it has to be dragged uphill or downhill to the stack.

The only drawback to the use of this implement is the fact that the stack must be built in the same field as the stuff grew in, and long distance hay cannot be thus carried. It is generally desirable to make suitable gaps in the fences, and to pipe and fill up corresponding parts of the ditches, so that several fields can be carried to one centre if they are small, or to expedite the removal of the sweeps from one field to another without folding up.

The desirable points about a sweep-rake are to have large side or driving wheels—as small ones back with difficulty—and to have a spring in the gearing which controls the set of the teeth so as to "give" a little in going over uneven ground. The points of the teeth must be shod with sharp iron tips, for thick, blunt teeth will not work on the implement in this country as they do on the western prairies. For backing purposes the use of martingale and surcingle as part of each horse's harness is desirable.

V.—Loader

This is a Transatlantic invention which has largely come into successful use in the south of England. It is made to fasten on behind a waggon or long-bodied harvest cart, and rakes up and carries upward the hay out of the swathe or wind-row, and delivers on to the cart or waggon as it travels along. A man on the top with a pitchfork levels the stuff and builds the load as it is delivered, while frames can be had to make movable sides, and thus form a sort of huge basket into which the stuff is delivered by the loader. By this means the packing on of a load is much more easy and efficient. The work is generally done better out of the wind-row, and for the purpose of making long small wind-rows to suit this work, some of the side-delivery horse-rakes are used in preference by many people to other implements.

Up to the present the loader is so wholly an American farm

implement that it has never yet been made with British improvements, and thus it is generally of too light a make for a heavy crop. A combination of the best points of the several makes into one would be a decided advantage.

VI.—Rick-lifter

In the northern and wetter parts of our Islands it is necessary to partially "make" the hay and build it up into little field-ricks of, say, from ten cwt. to fifteen cwt.—or about a one-horse cart load—and leave it some time to get fully "made" before it is sufficiently tempered to put into a large stack. The loading of these field ricks

FIG. 8.—RICK-LIFTER AT WORK.

The rick has been hoisted by the three shear legs and lowered on to the cart.

or pykes on to the carts used to be one of the heaviest and most laborious jobs on the farm, but in recent years the work has been done by various appliances. One arrangement is to have a tipping trolly backed against the rick, a chain is put round behind it, and the horse pulls a rope on a winding apparatus, and the rick is thus pulled bodily on to the platform of the trolly, which drops back to the horizontal, and the hay is thus loaded *en bloc.*

The cheapest and most convenient arrangement, however, is that made on the principle of three shear legs as shown in Fig. 8. These are run on castors or swivel wheels on the end of each leg, and are tall enough and strong enough to lift and carry the rick. A block-and-tackle arrangement is fitted on to these together

with the necessary sling, and by putting a horse to the end of the winding rope, the whole rick is hoisted up high enough to back a cart or trolly beneath it, thus enabling the rick to be loaded bodily on to a common cart. In this way only the triangular legs and sling need be bought extra, as the ordinary carts of the farm can be used for carriage. Indeed, there need be very little expenditure at all, because on many farms three straight young pine trees can be procured free of expense, and the necessary block and tackle fitted on at home.

VII.—Elevator

Throughout the haymaking counties of the south the stacking is commonly done by the elevator. The principle is simply a frame or trough fixed on a carriage with four travelling wheels, in which runs a travelling web. It is made to be raised and lowered by winding tackle, and when at its full height will overtop an ordinary stack. When in work the hay (or corn sheaves in harvest time) is thrown on at the ground end and the web carries it up and drops it over the top on to the stack. It is driven by a horse or pony gear in the ordinary way, though petrol motors are now often used.

This is an implement capable of very great improvement, and one that has indeed apparently been thrown together haphazard without much invention at all. To begin with, it is usually made too large. One of twenty-five feet height is amply sufficient for all ordinary stacks of, say, thirty to forty tons of hay, while those of eighty or ninety can quite well be tackled with one of the same size. If the stack is so large that the elevator does not quite reach to the ridge, then it is only a load or two that is required to make the ridge up, and the very occasional pitching upwards of this amount of stuff to an extra height is a small matter compared with the general handiness of using a smaller implement. Next the "trough," or frame in which the web revolves, is usually made four feet wide, while three feet is amply sufficient to carry up any possible delivery of hay in ordinary work.

The horse shafts for transporting the whole—with the fore-wheel carriage—should be at the hopper or lower end. This is the easiest end to move, and does not necessitate the complete folding up of the whole machine before it can be moved. It is a great convenience to be able to shift such a huge affair short distances, say from one stack to another, without completely folding it up, and this can only be done by having the shafts at the proper end.

Since the introduction of the sweep-rake it has been found desirable to do away with the large high hoppers formerly common, and either leave the front of the revolving web quite open, and so hinged on trunnions that it will come down to the level of the ground when the top is at its highest, or to have the smallest hopper possible in the form of a little movable slip of a board.

The teeth or prongs on the elevating web should be curved or hooked so as to catch the hay, for straight ones are apt to pass through the stuff without catching hold.

Again, the prongs with their carrying slats, which form the travelling web, should be much greater in number than those usually allowed: three for every two at present would not be too many, for when the trough is elevated to its highest it is difficult to get the stuff to carry up at all, as it always tumbles back for want of a sufficient number of teeth to catch it. As an alternative to this the speed should be increased: the horse will naturally go slowly round a horse-gear, and therefore the wheels should be designed for speedier work.

The chains of the web which carry the prongs should be of linkwork made to run over sprocket wheels so that there will be no slipping; any other kind will be unsatisfactory.

VIII.—Horse-fork

Where the hay is carried to the stack by rick-carriers, cart loads, or waggon loads—that is, where it is in a solid bulk together—the horse-fork is one of the most efficient tools for loading on to the stack, besides being much cheaper than an elevator at first cost. The fork part consists of a frame of grappling tines which open wide and grab the hay on the same principle as a steam-navvy closes when the winding rope is pulled, and being erected with a mast and swinging jib will hoist up and deposit a load of hay anywhere on a stack in a very few "grabs." The best forks are those with very long jibs, short standard, and guy-posts or ropes on the same principle as a common crane, as this form is easier to erect and has a bigger sweep of delivery than the other. Where a hay shed is in use the horse-fork is extremely useful, for by fixing a rail along under the ridge of the roof the horse-fork can be very conveniently utilised to run backwards and forwards on a suitable carriage in unloading and building up a bay of hay.

Experience has shown that a double rail composed of two angle irons under the ridge of the roof is the best for this purpose, and on

this a carriage with four wheels carrying the fork runs most satisfactorily.

With a sufficient gang of hands, some twenty-five to thirty tons of hay can be handled daily off the carts or field ricks—even more is sometimes done. On the other hand, a small farmer with two carts, a tripod rick-lifter, and a horse-fork can handle his stock of hay with two or three hands.

The horse-fork does not suit work with a sweep-rake because the load of hay brought up is spread out too wide and thin, and thus the prongs cannot get hold of a sufficient bulk at a time to keep the work going expeditiously. Therefore for this work the elevator is more suitable.

CHAPTER IX.—HARVESTING IMPLEMENTS

THERE is a tremendous series of harvesting machinery, ranging from the reaping hook—still in regular and common use in this country—to the great reaping and thrashing outfit, driven by a huge traction engine, used on the plains of the Far West. In this little country the ordinary string-binder is the highest development we are likely to see, but in the manufacture and use of the various implements we have made immense strides within recent years.

I.—Hook

The reaping hook is the harvesting implement which has come down to us from prehistoric times, and, in spite of all modern inventions, will probably never go entirely out of use. Long ages of experience demonstrated the form of curve of the blade that made the least resistance in severing the stalks of corn with a pulling cut which tired out the worker least, and now in our days the mathematician has shown that it is the particular kind of curve known as the "cissoid," where tangents to the curve at every point form equal angles with radii converging at a point in the centre of the handle.

There are practically only two forms of the hook or sickle—the tooth-edged form and the ordinary reaping form—but the last is the most customary and most important. A third form, in imitation of a scythe, has been in recent years introduced from America, but it is only useful for chopping off grass and rubbish about a garden.

In some parts of England a special method of reaping with the hook—called *bagging*—was practised, more particularly in cutting beans, and for this a heavy variety of the plain hook was used.

In the tooth-edged sickle the notchings are so cut that when the manufacture of the blade is completed the teeth point backwards or towards the handle, and therefore *hook* the stalks of corn so that they cannot escape cutting. The existence of the teeth on the edge of the blade renders sharpening unnecessary, whereas in the plain form this is frequently required.

In both forms the curvature is the same, and in work the signifi-

cant fact is that they sever the stalks with a direct pulling cut without any "sawing" action. If the curve were more or less than it is the blade would not cut without greater exertion and more tiring effect on the arm of the reaper—man or woman.

That the reaping hook will probably never cease to be used is due to the fact that in some years our corn crops are so lodged that they cannot be cut with the string-binder, the common reaper, nor even the scythe, and men who can use the hook have to be found, and a great wage paid for reaping and tying in the same way as our forefathers did. As time goes on, of course, our machinery becomes more and more perfected for handling heavy and tangled crops, and we keep on developing varieties of crop with stiff straw which will stand up, while we likewise endeavour to control the growth of the crop by using phosphatic in preference to nitrogenous manure. But after all this there comes a season, perhaps once in twenty years or oftener, when the hook has to be relied on.

In the old days, when the corn was all reaped by hook, the reapers went in bands, with one man to tie the sheaves and set up to every six reapers. Each could cut from a third to a half acre daily, according to the nature of the crop, so that a band of seven could do at least two acres daily. The change from work of this sort to that of the string-binder, and all within the memory of living people, exemplifies the immense strides that farm work has made.

Apart from harvest work the hook is in common use for trimming hedges in place of using the regular "switching" knife, while for cutting down thistles in pasture or any vegetable rubbish about buildings, gardens, fences, etc., hooks are necessary, and two or three are to be found about every farm.

II.—Scythe

Although the scythe as an important harvesting implement has been for a quarter of a century or more largely superseded by the reaper and binder, yet it is not historically old, for though hay had long been cut with a scythe, its adaptation for corn was of a much later date. In fact, reaping by scythe has been in force for less than a century. Nowadays no one would think of reaping a whole crop with this implement, even on small farms, when a second-hand one-horse mower could be bought cheaply, but there are still many occasions where a scythe must be used. For machine reaping, for instance, it is necessary to cut a roadway round each field to get a start with the

machine, while lodged pieces of grain are often better cut with the scythe if they are lying *away* from the machine. Again, there are some areas of country where the arable land is so broken up by rock that a machine can scarcely work conveniently or satisfactorily, and the scythe must be used. As a rule, in an ordinary field, if the crop could be cut by the scythe it could also be cut by the reaping machine—cutting one or two sides only if the crop is much lodged, and running empty round the other sides of the field.

The great improvement, which practically converted the hay scythe into a corn one, was the fixing of the cradle or rake on to the tool. This forms a gatherer of the stalks of corn as they are cut, and carries them round to one side of the sward to lay them in a swathe ready for lifting and binding up into sheaves. The cradle may be made of fine iron prongs, but the helve or handle of the scythe itself must be made of wood. Iron has been tried but has never made a satisfactory handle, while of all the woods willow is the favourite, partly on account of its lightness, and partly because it can be bent easily to the required shape.

The blade of a scythe is from forty to forty-two inches long; the sweep usually covers a sward of seven feet, and fifteen inches wide is a good cut for each sweep made. A man at straightforward work can do from one acre of wheat up to two acres of oats in a long harvest day.

The setting of the blade on the sned or snaith (handle) is an important point, for on this depends the ease or the reverse of the work in mowing. Almost every man requires a setting to suit himself, but the general rule is that, when holding the tool in the working position, the blade should be flat or parallel to the ground, and that when the lower handle is held at the haunch, the point of the blade can be touched by the toe. When set thus the whole can be used with an easy swing, as it balances itself in the hands.

III.—Reaping Machine

The first workable reaper used in this country—as mentioned before—was invented by the Rev. Patrick Bell, of Carmylie, in Forfarshire, about 1826. This was by no means the first attempt that had been made, as other inventions had been at work—both at home and in America—for at least forty years previously, but it was the first form that was a practical success, though it only cut the corn and laid it in a long swathe at the side. The first mower on the principles now adopted was introduced in 1851 by McCornick, but

since then there have been very many and great improvements. We have now several varieties in use where the string-binder has not yet been adopted, such as the simple reaper, the combined mower and hand-delivery reaper, the self back-delivery, and the self side-delivery machine. All of these have been largely used, and are yet in much use, though, of course, they are on the decline now, as the modern cheapening of the string-binder tends to cut them out. The general points mentioned with regard to the mower apply to these also, but a slower speed of the cutting part is necessary and desirable, while "sickle-bladed" knives may be used, that is, with the edges serrated as with the toothed reaping hook, thus doing away with the necessity of sharpening. "Sickle" knifes are largely used in some districts, especially with string-binders.

In purchasing any one of these machines several matters require attention. In the self-delivery machine the rakes ought to be controllable, that is, be set to put off any size of sheaf required. These are now made with short arms so as to give more power, and the old-fashioned long-armed variety is now out of date. The bearings should be of the roller kind, to lessen friction as much as possible, and the connecting rod or pitman should be of wood, to stand the jarring. An iron one sooner or later, takes on the crystal form of grain, and becomes brittle and snaps, and it should be as long as possible and with the most direct action. Two horses are necessary for the draught, as one is not enough. Some of the old makes for one horse had a very narrow cut, and took a long time to get over the acres.

There should be dividers or prongs for separating the standing from the cut corn at the farther end of the cutting bar, and also a similar arrangement next the truck of the machine.

The seat ought to be put on so as to balance the whole when in work—not on the pole as it once was fixed, but behind the driving axle.

One of the principal arguments in favour of continuing the use of the side self-delivery machine is the fact that the stuff can be left untied for several days until it gets "made" somewhat, and becomes fit for stacking quicker. This principle is so generally accepted that some years ago a machine was brought out which picked up the loose sheaves from the ground and tied them. It is only in the drier south country that this system of letting the sheaves lie untied is practised, and consequently the side-delivery is not in much demand in the north or west, where either a string-binder or hand-tying straight away is preferred. In the wetter and stormier districts in the north

and west the hand delivery generally works better, because the grain is more often lodged, and a self-delivery machine does not do good work with such.

IV.—String-binder

This may be looked on as the acme of machinery in connection with the farm, and the one above all others which has revolutionised farming. As far as inventions concern the good of the human race, the steam engine only has taken a higher place in its influence on the conditions of life generally. While the steam engine gave us power to drive machinery to do work, the string-binder made it possible to save our corn crops on a greater and quicker scale, and thus gave the nations cheap bread.

1. *Important Improvements.*—The modern binder is very much simplified and cheapened, and one might almost buy any of the makes of well-known manufacturers. It is only necessary to point out what are some of the more important improvements. All binders now are made on the principle introduced by Marsh in America, that is, a conveyor canvas web running as close to the ground as possible, and an elevator web or webs which carry the corn up to the binding table. Marsh brought out this idea, and adopted it for hand tying: two men stood on a platform and bound the corn into sheaves as it fell on a table in front of them, and dropped these off as the machine travelled forward. The modern string-binder was simply this machine plus a mechanical tier. The tying apparatus at present in almost universal use was the invention of Appleby in England, and may almost now be reckoned perfect in action under ordinary circumstances.

Roller bearings ought, of course, to be used throughout: a vibrating buttor is infinitely preferable to a revolving web: the canvas on the lower or cutting platform should have spring-set or adjustable rollers so as to allow of the shrinking of the canvas when wet: the driving wheel should be as low as possible consistent with ease of draught (thirty-six inches is the usual diameter) in order that the elevating canvasses may be low also, and the sheaf be dropped gently on the ground (an extra conveyor-roller over the top of the driving wheel helps this very much): the driving sprocket chain should not run too near the driving wheel to prevent clogging with dirt, and a couple of side scrapers on the wheel are a help to clean work in a wet harvest: the dividers should be made to fold up out of the way during transport through gates;

the transport wheels should be easily fitted on: the sheaf carrier where used should be of the swinging kind and not the tipping form, as the former works best on uneven fields, and so on with many minor points.

It is a very great improvement to have double shafts and a saddle on one of the horses, and thus carry the binder like a cart. This eases the strain on the horses' necks immensely, and the extra shaft can be very easily fixed on the pole usually sent out with the machine. No one seems to have fitted on a third wheel

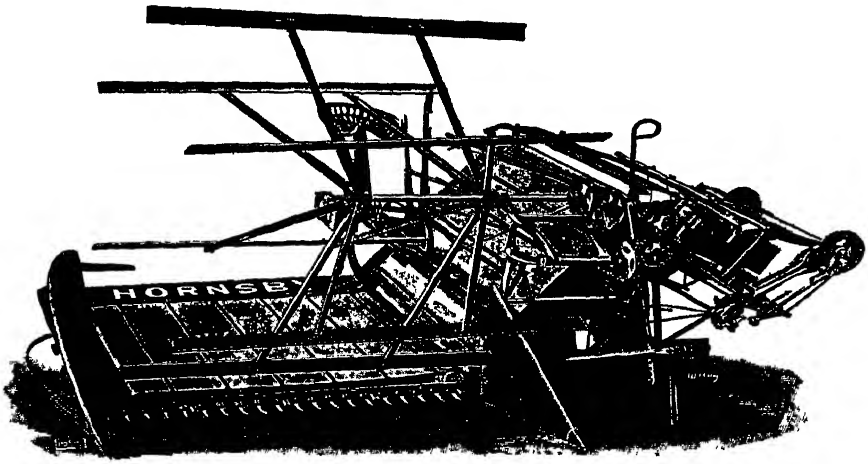

FIG. 9.—STRING-BINDER.

in front to carry the machine, but the point is worth the consideration of inventors.

2. *Conditions of Working.*—The ordinary conditions of the work may here be set out as a guide. A six-feet swathe is the usual width of cut, and with this width and the horses walking at two and a half miles per hour, in that time an acre can easily be done. On fairly large farms it is customary to tell off two men and four horses to the work, and these yoke alternately—one gang on and one off—and thus there is no stoppage from sunrise to sunset. From twelve to sixteen acres can be done daily where the crop is all standing well and the work is straightforward. If the job is let at piecework, then fifteen pence per acre is a common price, and the workmen can make big harvest wages at the job. In a smaller way, three horses in the machine all day get on very well,

and even two, if given two meal-times off, will do the work quite comfortably with the modern machines.

The amount of string used depends on the crop and the size of sheaf fixed on, but usually a ball per acre is needed, or, say, three to four pounds. Good quality twine only ought to be used, for if it is inferior it breaks often and loose sheaves are a nuisance and cause a great loss of time at a critical period.

The size of the sheaf can be regulated by the setting provided for the purpose, but it is a good plan to make the sheaves small, especially in damp weather. The packers put more into a sheaf than was done in the old hand-binding, and if the stuff is damp or wet it takes a long time to dry; hence large sheaves are objectionable.

There is not much good done in cutting the stubble too short: it means only so much more straw to be carted home and carted back again as manure; therefore it may as well be left on the field to be ploughed in. Besides, cutting a high stubble means greater ease to the horses and less chance of the cutting parts encountering stones, etc. The usual draught of a binder is about three cwt., but of course varies according to the crop and other things.

Where a crop is of moderate length and all standing there are no straws lost on the stubble, and raking afterwards is quite unnecessary. Two men will set up the sheaves in stooks as fast as cut and tied, unless the crop is a very heavy one. Hence it is quite possible for three men and two or three horses to cut, tie, and stook a very considerable harvest without any other help at all, and within a reasonable time—extra hands only being required at stacking.

A straight standing crop is of course a very great help to tidy and satisfactory work. With such the cutting can be carried on round the four sides of the field, while in a lodged crop it may be only possible to cut one side and slip empty round the others, or it may not be possible to cut with the binder at all. Future improvements, therefore, are to be looked for in selecting varieties of crops that are naturally stiff in the straw and not likely to lodge, and in manuring for corn and not for straw.

The ordinary rate of work is one acre per hour, cutting and tying. If this is compared with the work done by the shearers with hooks, which was the only method in our fathers' time, it will be seen that one man now does as much work as eight to ten did in the old days. As this is the most touchy and critical job of the year it will be realised how much easier the work is now than formerly, and how the labour question has been revolutionised on the farm.

CHAPTER X.—CARTING IMPLEMENTS

THE easy transport of material has been one of the great problems of the human race from the earliest times, and cheap and convenient carriage is a problem yet. In the beginning of things, and among savage tribes at the present day, everything was carried on peoples' backs, and the invention and construction of various kinds of carriages for bullock- and horse-power came comparatively late, while the application of steam-power is not yet a hundred years old and oil and electricity belong to our own times. The consideration of means of transport in this chapter must, however, be limited to the ordinary carriages of the farm.

I.—Sleigh

Probably this is the oldest form of transport vehicle, as the most natural thing to do would be to fasten a bullock or a horse to anything and pull it along the ground, and later to make a flat carriage on the same principle on to which smaller articles could be piled for moving.

The sleigh is in constant use in America and other countries where the snow lies deep and long in winter, as it is then the only means of transport. Four-wheeled waggons, too, are so made that the bodies can be taken off and fitted on to two sets of sleigh runners for winter use. Sleighs on the other side of the Atlantic have had as much skill and care bestowed on their invention and manufacture as have waggons, for besides those used for pleasure, large ones to carry from two to three tons are common.

In this country the sleigh is only used occasionally, but for certain purposes it is one of the most useful implements of the farm. Where land is being cleared of large stones, or where the roots of trees must be moved, it cannot be dispensed with, as large and heavy articles may be rolled on to it which could not be lifted into a cart. Again, for moving the carcases of dead animals it is very useful, and unfortunately it is too often needed for this purpose on a farm.

A sleigh for farm use is very easily made, only two runners of timber say four inches by three inches in section, covered crosswise with one and a half inch boards, is practically the whole thing complete. The timber ought to be oak for preference, but ash runners are suitable. These should be shod with old cart-wheel tyres straightened out, and with the front rounded up a little. An iron tongue with a ring at each end fastened below the platform between the runners completes the outfit, and with this any heavy body up to a ton or more can be moved. The platform ought to be made narrow enough to pass through the doorways of the farm buildings, and six feet long by three and a half feet wide will be found a useful size.

II.—Box Cart

Each district has its own type of cart, originally designed by the local wheelwrights, and to which the farming community often tenaciously adheres although there may be other and better types in the market. Generally speaking, the carts are of inferior design in districts where waggons are common, for the reason that, most of the transport work being done with the latter, there has not been the same necessity or inducement to improve and develop the design of the local varieties. This drawback is disappearing gradually, however, for the teaching of implement shows is not lost, while the ease with which communication is made with distant large makers who have taken some trouble to improve the style of cart has led to the more common use of modern forms.

The ordinary farm one- or two-horse cart ought to be more or less convertible, so that it can either be used as a box cart—pure and simple—for dung, roots, or any other heavy solid material, or by the fitting on of a harvest frame or fore-and-aft "ladders" (see Fig. 10), be converted into a harvest cart for corn and hay and large enough to carry a load. A cart big enough in the box and strong enough to carry up to two tons, to be pulled by two horses in line, is to be preferred to two one-horse carts for general purposes; it costs less than two smaller carts, one horse can handle it for lighter jobs, while it is much easier to drive two horses together than two single horses in two carts.

Some of the points desirable in a cart may here be considered. The wheels should be as large as possible in diameter. They are usually four and a half feet, but the London hay carts run up to over five feet. The larger the wheel the easier the draught. These should also be as broad in the tyre as possible—say four inches—for

the broader the tyre the less it sinks in the ground, and the easier it is to draw.

There may be a difference of anything from 20 to 50 per cent. against a small narrow wheel as compared with a large broad one in the matter of draught on fields or soft farm roads. There may be little or no difference on a hard, smooth road, but for the ordinary farm cart it is work on the land that must be arranged for, and whatever the size of wheel a wide tyre should be adopted.

The hubs should be rounded off, for iron rims or "pan-hoops" are only made to catch gate posts, where a round hub would grind

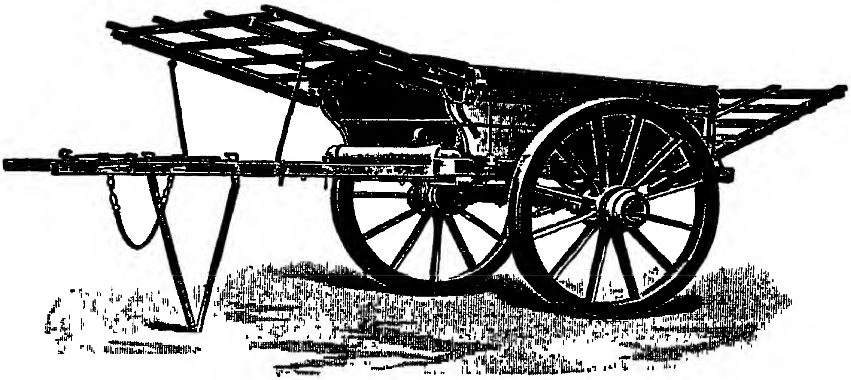

FIG. 10.—TIPPING BOX CART WITH HARVEST LADDERS.

past. The wheels should also have a "dishing" of three inches to withstand side shocks, and the standard width between the two is four and a half feet.

Iron wheels have never been adopted on carts, though sometimes iron hubs are used. For one thing an iron rim would be so shallow that it would pick up the dirt inside it very badly, while even the fitting in of "staggered" iron spokes would not stand the jolting.

For some unknown reason wheels have always to be greased instead of oiled, a process which involves the use of a lifting-jack and the taking of them off. At some future time we may have wheels made to be oiled by means of an oil hole like other modern pieces of machinery, and thus save much waste of time and trouble. It is said that for slow moving axles, like those in a cart, greasing is the best and lasts longest, but an arrangement for oiling would be a great convenience.

The box part ought to be made to tip or tilt, though a simple and efficient tipping latch has not yet been invented, but purchasers would be well to avoid the elaborate styles. The "shelvements," or enlarging side boards, should be permanently fastened to the body and lap over the top of the wheels : this arrangement suits conversion into a harvest cart, while it is a much better style than the straight up and down movable boards which are in the way for harvest work, and give less room for dung or roots or any other heavy stuff.

The ordinary slow walking pace at which carts and waggons are moved reduces the necessity for the use of springs, while the carriage of a ton or more at a time would require very powerful ones to carry the load, therefore they are dispensed with.

The weight of a cart is a point of some importance. This varies considerably in various districts according to the variety of make, but five cwt. to ten cwt. are the usual limits. Where a considerable amount of stuff is being weighed in cart loads, it is a good plan to have the tare of the cart marked on its side.

III.—Long Cart

This name is given to the variety of cart built with a permanent long-framed body for harvesting purposes. The ordinary box cart, as before explained, should be convertible into this style by the use of a portable frame or fore-and-aft ladders, but for many purposes the present variety is more desirable. For one thing, it can be made longer and wider than a portable frame, and often lower wheels are adopted, so that a big load can be put on without pitching the hay or sheaves very high.

The same points noted in the case of the box cart apply to this form also. It is often a good plan to have the same sets of wheels to suit both kinds of carts, so that they may be exchanged and thus economise in outlay. When haymaking or harvest is in progress the box carts are not wanted, while the exchange of wheels can be easily made.

There should be no cross-rail behind a long cart, but the end should be left quite open so that sacks of grain, cake, or any other goods can be easily loaded or unloaded. No doubt the cross-rail strengthens the frame, but its place must be taken by iron side brackets.

For ordinary farming purposes, however, the box cart that can be fitted with ladders is the cheapest and most convenient form for

general use. It does not necessitate having two distinct carts, as the frames only are necessary, while less shed room is needed. The drawback is that a box cart thus adapted is seldom made so long or wide as the ordinary long harvest cart; thus, so large a load cannot be built on it, or else it requires more skill to do so. This drawback could be easily remedied by having frames that reach well over the horse's back in front, and well back behind, as in the London hay cart.

A little point desirable in carts of all kinds is to have supports permanently fixed below the shafts, so that the load can be left standing at the level, without the use of a trestle, when necessary to unyoke from the loaded cart. Again, extra hooks for the use of a trace horse must also be provided.

The number of sheaves of corn that can be loaded on a long cart will depend on the size of the cart and the skill of the builder. A good, fair load for one horse is 180 where the ground is not steep or soft. The same cart will carry a "load" of hay of eighteen cwt., *i.e.* thirty-six trusses, each of half a hundredweight, and a corresponding amount of straw trussed up.

An adjunct to a long-bodied cart is a "stand" of ropes. This consists of one stout rope seventy-two feet in length, fastened at the middle point round the axle underneath, thus giving two ropes about thirty-six feet each in length. Each is fastened lengthways over the load and pulled down tight when in use, but coiled up in a special way at other times.

IV.—Waggon

Notwithstanding the fact that the trials in 1874 of the Royal Agricultural Society of England demonstrated the superiority of the one-horse cart over the two-horse waggon for general farm purposes, the latter still remains a favourite in the southern half of England, and is likely to continue so. This predilection is, no doubt, largely a matter due to the nature of the country: on level ground, or where the undulations are comparatively small, waggons have several advantages over carts, while in a hilly country they are not suitable at all. The Royal Agricultural Society of England trials showed that in draught per ton the cart excelled the waggon by 28 per cent. On the other hand, where a cart will carry a ton a waggon will take two and a half tons easily, while three and a half tons are a common load on a good turnpike road. The saving of time by thus working with double or triple loads on one journey is important, while in haymaking and harvesting the big waggon loads soon clear a field.

So useful are waggons found for this work in some parts of the country that the "waggonette" has been introduced, a sort of combined arrangement whereby a two-wheeled cart is made into a four-wheeled waggon by taking off the ordinary shafts and fitting on two fore-wheels with shafts—all swivelled to lock round—and then putting a large frame over all with "ladders" to hold the hay or sheaves.

Many farmers from the north, who were used to the ordinary one-horse cart only, have, on coming south, found it desirable to have one or two waggons for long journey work, to and from the railway station and the farm. A waggon does not suit dung-carting, root-carting, or other ordinary work, but for corn, cake, coals, tied hay or straw, etc., over several miles of a good road, the waggon is much superior to the cart.

The general points regarding the make of a cart apply equally to a waggon. The hind wheels are usually five feet high, and the fore ones three feet ten inches. This height is, of course, a drawback as compared with a cart, but it makes for easier draught, while the fore-carriage must lock under the body of the waggon to a certain extent. It is not desirable to allow the wheels to lock completely under, because of the danger of capsizing a huge, top-heavy load of straw or hay, while a "tongue" connecting the carriages of the fore-and-aft wheels should be part of the arrangements. By this means semi-locking only is possible.

Usually the waggon is provided with one pair of shafts and the second horse goes tandem, but two sets of shafts are common for yoking side by side. The tandem system is the favourite, however, and takes up the least room.

In America, where waggons are almost exclusively used, and carts are scarce, the yoking is generally done with a central pole between the two horses abreast, and with whipple-trees instead of cart harness.

Waggons are fitted with fore-and-aft ladders for harvesting purposes, while, of course, the sides, as in the case of a cart, must lap over the wheels. A full-sized waggon thus gives a great area of bed on which to build a load.

In harvesting a waggon will easily take 360 sheaves or double that of a cart, while 400 can be piled on if desired, and the allowance of hay or straw will correspond.

The rope used for a waggon is usually of stronger make than that of a cart, and 100 feet is the length allowed. It is generally fastened *across* the load twice from side to side, and made secure to iron loops on the sides of the body.

There are, besides these carriages, a very great variety of carts and waggons used on the farm for special purposes: the milk "float" with cranked axle to give a low box to carry "churns" of milk; the cattle cart—a van set low with cranked axle to carry live stock; the spring cart, for driving and doing light work with a pony about the farm; the lorry, practically a waggon without sides; and so on with many others.

CHAPTER XI.—BARN IMPLEMENTS

The handling and marketing of the crops, the preparation of the food for live stock, and the attendance on the animals while housed in winter necessitate the use of a whole series of implements and machines, some of which may be fixed and stationary in the buildings, while others are portable. They may be grouped into three classes: Grain preparing, such as the Thrashing Machine; Food preparing, such as the Chaff-cutter; and Stock tending, such as the Milking Machine.

I.—Thrashing Machine

The separation of the grain from the straw in the case of the common corn crops, and of the seed from the haulm of many other crops, involves the use of one of the largest and most important pieces of machinery on the farm. In the case of clover seed, however, a special "huller," or thrashing machine, is sometimes used.

In the old days thrashing was all done by the flail, which has been in use down to our own times, but the last few generations have seen the development of the thrashing machine. The ordinary thrasher of to-day is in some respects a great improvement on those of, say, twenty years ago, although we have a long way to go yet in the evolution of a perfect one.

Meikle, a Scottish mechanic, was the first to bring out a workable thrashing machine—about 1786.

In his machine the face of the drum was fitted with rows of iron pegs, and the corn was fed first through two fluted rollers, so that the pegs hit the heads and knocked the grain out as the drum revolved. This is the principle of the Scottish "peg-mill," which was at one time fitted up on almost every farm in Scotland, and is even now in common use, driven by horse- or water-power. The drum revolved at 180 to 200 revolutions per minute, and the pegs hit the corn twenty times per foot of length. For ordinary or small farms it was, and is, quite as good as the newer forms, and it is worthy of note that it is the form of drum used on American

thrashers ("separators"), where enormous quantities are passed through a machine in a day.

In this country in more recent times, however, the "rubbing" principle has found greater favour, and in the portable form is largely used to travel from farm to farm. The drum in the "rubbing" machine is formed of a series of ribs which carry fluted steel mountings, and the grain is rubbed out between the revolving drum and the grated framework or "concave" which encloses it. The drum or cylinder revolves at about 1,200 per minute: different makes and sizes vary somewhat. The sheaves are fed in as loosely as possible, but broadside on. Thus the straw is not broken as it is with the peg-mill form, and is delivered outside by the shakers in a way to suit bundling up or trussing either by hand or by trussing machine. It is this superior treatment of the straw that is the point in favour of this machine in this country, for the straw is an important item either as live stock food or as a saleable commodity, whereas abroad it is a waste bye-product.

The thrashing of corn involves the separation of a sheaf into five or six products—the grain, the tail or small corn, the weed seeds and rubbish, the straw, the cavings, the chobs and the chaff—but unfortunately the modern portable machine has usually a dozen to fifteen openings out of which some bye-product is emitted. A future improvement is to do away with one half of these, and thus simplify the work considerably. In the modern American "separators" there are practically only two deliveries—the grain and the straw; the cleaning and grading of the grain is an after consideration, while straw, cavings, chaff, etc., all fall into a huge fan at the rear of the machine to which a movable sheet iron pipe or funnel is attached, and the whole is blown out on to a heap to be stacked.

The most recent improvement in this country is the adoption of the self-feeding arrangement, whereby the sheaves are thrown on to a travelling web, and carried below revolving knives to cut the bands, then under revolving forks that spread the sheafs, which are then dropped into the drum through the feeding aperture. (See Fig. 11.)

The automatic feeder does away with the manual work in this matter, but for hand feeding it is necessary to have a "safety" feeding arrangement so that there will be no danger to the attendants, otherwise there may be serious accidents. The concave has to be regulated according to the nature of the corn to be handled—wide for beans and narrow for wheat, for example—so that the drum shall rub every grain out of its setting and at the same time not bruise it, but just hit the happy medium

In this country the grain is usually measured by the sack of four bushels as it comes from the thrashing machine, and payment of the work calculated by the quarter so measured. On the American continent, however, a weighing machine which registers the number of bushels passed is the method adopted; the grain is delivered loose into box carts and taken to the granary to be dumped through a shoot in the wall, and possibly " elevated " into the storage.

The amount of grain thrashed per hour depends on the size of the machine, and the nature of the crop, but the ordinary

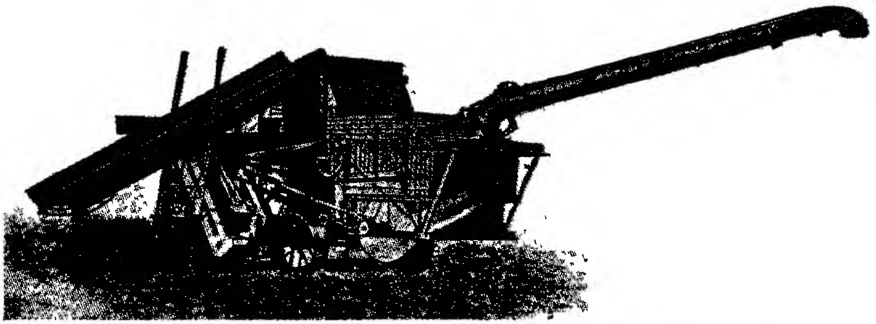

Fig. 11.—Thrashing Machine with Self-feeder and Wind-stacker.

portable outfit can pass from fifty to seventy bushels of wheat per hour, and a third more of oats or barley.

A great deficiency in the machines of this country is the method of delivery of the cavings and chaff. The former is usually delivered between the rear wheels of the machine and has to be pulled out and the space kept clear with a hand-rake. It would be quite easy to fix a spout to deliver the stuff at the side and away from the machine itself, as is done by the French on their thrashers.

The chaff delivery is excessively bad. Usually it is simply blown on to the ground below the machine, and has to be raked on to a sheet to be carried away. If a sacking contrivance is affixed it never works properly: it either becomes choked or the chaff blows past it. A satisfactory method of handling these two side-products of thrashing has yet to be designed.

The appearance of a stockyard after a day's thrashing is enough to break the heart of a man who loves to keep things tidy about

his farmyard. Heaps of waste straw, cavings, chaff, etc., are left behind, and these get spoiled if not put quickly under cover before rain comes to wet them. This is not altogether the fault of the thrashing gang, for the machines at present on the market are not designed for tidy delivery of the stuff.

Where the straw has to be much handled after thrashing the use of the trusser is a great advantage. It is fitted on behind the machine and ties the straw up exactly in the same way as a string-binder does. The trusses so formed weigh about twenty-four pounds each in the case of wheat straw, and are handy to load on to a cart or build up into a stack.

The use of a fixed thrashing machine at a homestead allows of the fitting up of many labour-saving adjuncts. The corn has all to be carried to the machine in the sheaf form, but this is much more easy than the carrying of the grain, straw, chaff, etc., separately to a place of safety when the stack is thrashed where it stands in the open. From the fixed thrashing machine the grain can be delivered automatically into the granary, or other apartment, by a small elevator or a travelling "shoe": the chaff can be blown direct into the chaff-house; the straw delivered by an elevator or travelling web on to a heap in the straw shed, and the whole done under cover—provided the barn has been previously filled with sheaves—without the work being hindered on a wet day. By labour-saving appliances like these, the work of thrashing can be tackled by the regular men on the farm without the employment of "casual" labour, while it can all be done on wet days—a double advantage.

Fixed machines, however, are not suitable in the great wheat or barley growing districts where the straw is either sold or used to litter yards to tread into "muck," because such enormous quantities of straw could not be handled in a barn. Under such conditions the crop must often be stacked in the fields where it grew, and thrashed there, and a portable outfit must be used. Where, however, oats forms the principal crop, and the straw is used for fodder, the fixed machine is the best.

II.—Corn-dresser

A certain amount of cleaning or dressing of the grain is done by the thrashing machine, and in the "double-blast" or "finishing" variety the grain is prepared ready for sale straight away, but the majority of farmers prefer to have in addition a hand-driven machine for the more careful and better dressing of the corn, especially for

seed purposes. The general principle of all these dressing machines is an arrangement of a fan to make a blast to blow chaff, light grains and dust out of the sample, and then the grain passes over a set of reciprocating screens which take out the small grains and weed seeds, and delivers the clean grain well sized at one end.

The points of importance about an efficient machine are that it should have the blast sufficiently strong and concentrated to blow everything out of the corn, and slips of board should be inserted to direct the full blast on to the grain : that it should have screens to suit all kinds of grain and seeds—beans, for instance, as well as wheat or clover seed : and that it should have an adjustable screen for sizing the grain, *i.e.* taking out the small ones on what is known as the Boby principle, after the name of the inventor.

Shooting down corn in a heap from the thrashing in the first instance, and then dressing it afterwards, makes a much more equal sample of grain. There are generally two or three qualities of grain in a stack, and if this is sacked up and sent off as thrashed, some parts will be worse than others, but when first put into a heap and then dressed up a better even sample is prepared.

It is possible to dress ten quarters of corn per hour, but seven to eight are quite enough for even, steady work, and less is better where an extra good sample is desired.

III.—Chaff-cutter

Cutting hay and straw into short lengths to make "chaff" or "chop" is one of the important items of indoor work about a farm in winter-time, and there are many points to be taken note of about the machine that does the work.

As the outcome of a generation of experience, the type of cutter adopted in this country is that with a heavy fly-wheel, to the spokes of which are fastened "scimitar" blades, from two to five in number, according to the size of the machine. The stuff to be cut is fed through compressing toothed rollers which force it against the blades ; these cut it off as they pass at every revolution of the wheel. The pressure of the feeding rollers is balanced by a hanging weight on a lever.

The feeding speed of the rollers is controllable by suitable gearing, but half-inch chaff is that most usually made. It may here be pointed out, however, that for cattle of all kinds the seven-eighth inch or whole inch length would be much better, because, though a horse can use

short chop with his corn, cattle must have it long to chew the cud satisfactorily. Usually some long fodder fed to cattle keeps their digestion right, but inch-long chop would be much better.

Unfortunately no machine made in the British Islands will tackle inch-long chop ; the gearing and knives will cut it all right, but the sieves or elevator or other parts will choke up with the stuff, and the operator is compelled to come back to the small cut. Nominally the machines will cut long chaff, in practice they fail.

Chaff should be sifted to take out the long straws which somehow always get pulled out by the knives without cutting. A riddle fixed below is therefore an advantage.

For bagging purposes the ordinary elevator is suitable for short-cut stuff, but it always, as stated before, chokes up with the long lengths, while the latter cannot be bagged quickly enough to keep the machine going.

The best delivery of all is the fan blast. Even for the portable chaff-cutter, that is taken from farm to farm, there is now in the market an arrangement of portable sheet-iron piping which can be fixed from the chaff-cutter into the barn to a hundred feet distance and a blast fan on the cutter blows the chop into the house. Where the chaff-cutter is fixed indoors it is a good plan to have it on the ground level—in order that nothing will have to be passed aloft by manual labour—and then to arrange a mechanical delivery of the chaff by elevator or blower.

For the very largest cutters in this country the concave-edged blades are preferred. The reason for this is that as the wad of straw in the feeding-box partly yields before the blades, and has an extra solidity given it at the final cut of the blade, it is desirable on these large machines to have this finish nearest the axis of the wheel, where there is the greatest leverage power.

The knives are fitted with set screws or studs so that the cutting edge can be adjusted to closely shave the jaws of the feeding-box. This setting should be seen to frequently—indeed, every time the blades are sharpened.

By law all chaff-cutters must be provided with safety-feed to prevent the operators' hands being entangled ; a lever controls the clutches, so that with a movement of the elbow the feed may be reversed.

A travelling web in the feeding-box is a great help in the work and is usually fitted on to all big machines. A large and wide feeding-table attached to the feeding-trough is a great advantage ; on to this the fodder is laid handy for the feeder.

IV.—Pulper

It was explained in the volume on "Live Stock" that much of the preparation of food for live stock was labour thrown away. Among other things pulping roots was superfluous work according to experimental tests. Nevertheless, the great majority of farmers believe in comminuting the food in various ways by chaffing, grinding, pulping, etc., in the belief that it at least makes the food more palatable and more easily served to a large number of animals, and that it "goes further."

From the nature of the work a pulper can never be of a very large size, because the pulping of from one to two tons of roots daily is all that is required on ordinary farms. The force required is therefore quite within the power of one horse, and in practice the horse that carts the roots from the clamp can also drive the pulper with an ordinary circular horse gear. In these days the small petrol-motors or oil-engines cost much less than a horse to buy, or to keep in work. These are being largely utilised to this end, and they suit exceedingly well for work of this class.

The barrel pulper is better than the disc form, because each cutting tooth is separately set in a plug of wood in the face of the barrel and is thus easily repaired, while for horse or other power the barrel form can do more work—up to four or five tons per hour. The latest forms have a revolving cleaner attached—a ribbed barrel through which the roots pass, and in revolving get all dirt and stones knocked off. It is essential to get rid of the stones at least, as these would injure the machine, and hand cleaning is out of the question in these days.

Pulping is mostly done in the south country; in the north the roots are plentiful and the straw fodder good, while in the south the straw is inferior and the root crops small, and it is, therefore, better, under these circumstances, to improve the palatability of the food, and make it go as far as possible by pulping and mixing the pulp with chopped straw.

V.—Milking Machine

Dairy farmers have for a generation been devoutly wishing for an efficient machine to milk their cows. There is no work about the farm that requires more skill than milking by hand, and there is none where second-rate work will do more harm and entail more loss to the owner. We seem to be now within sight of a solution of the

mechanical difficulties of the problem; hence a description and illustration of what has up to the present been accomplished will enable a student of farming to judge what we are likely to attain to in the future.

It is now generally agreed that a machine must imitate the sucking of a calf, and not the action of the human hand in milking; therefore, the principle of a vacuum is adopted in the apparatus, which is subject to a continuous breaking or "pulsation." This pulsation is better than a steady suction, as the latter becomes painful on the teat of a cow after a minute or two, and also tends to a congestion of the blood in the parts.

The fixed apparatus consists of a one-inch galvanised pipe fixed down a cowshed—over the shoulders of the cow—about seven feet from the ground. This is led outside to the engine or apparatus producing the vacuum. The apparatus may be of various kinds—the best being a vacuum pump driven by a motor.

The milking machine itself consists of a can or vessel which can be sealed airtight by a lid and rubber band. On the top of the lid is the "pulsator," an arrangement of small double pistons in cylinders which "pulsate" backwards and forwards, making and breaking the vacuum in so doing. From this, two sets of indiarubber tubes lead to each cow. At the end of each of these tubes are four metal-bound indiarubber teat cups, which are adjusted to the teats while in action. (See Fig. 12.) Each machine has thus a double set of these to do two cows at a time.

When in work the can with pulsator and tubing is set between two cows, a rubber tube is fixed on to a brass tap in the piping overhead, and this is turned on. The vacuum which is made by the pump in another apartment is communicated by the pipes through the can to the teat cups, and when these are put on the teats and the pulsating vacuum applied, the milk is sucked out of the udder and flows into the attached milk can.

The writer of this volume has had an extensive and expensive experience with the use of the milking machine, and would like to point out what must be the conditions of success in the future development of the machine.

It must enable an operator to do at least double the work done by hand. Two people doing the work that required three before is no benefit at all, because the cost of the installation—up to £3 per cow, plus the expense of running, the depreciation, the interest on outlay, and so on—amounts to so much that the whole thing is liable to be a "white elephant" Cases occur where three people milk

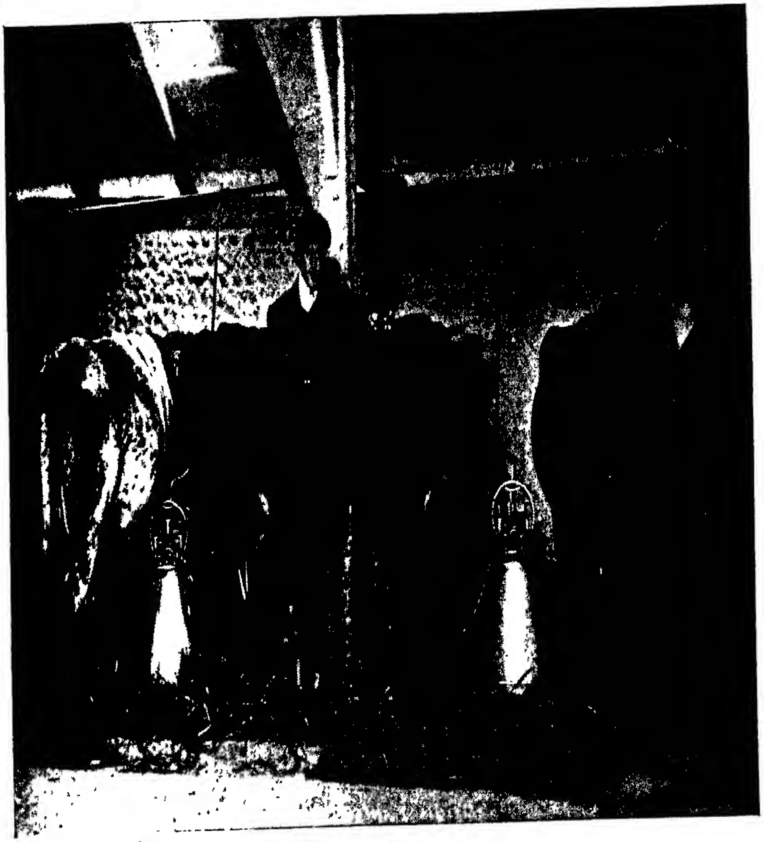

Photo Arnold, Shoreham.

FIG. 12.—MILKING MACHINE AT WORK.

thirty cows and four people forty cows with the machine ; it is evident better results would be obtained by hand alone.

The next point is that the machine must do without hand milking or stripping afterwards. There will always be a proportion of cows, say, 5 per cent., that will never "take" to machine milking, and must therefore be eliminated, but the herd, as a whole, must be so clean milked as to do without "stripping out." The alternate machine and hand is objectionable, while requiring extra labour, and the object of the apparatus is to save labour.

Another thing seems to have passed unnoticed in the matter of saving labour by the use of this machine. The attendants (in winter-time, at least) have to feed the cows, clean out the manure, groom the animals, cart in fodder from the stackyard, cart in roots from the field, pulp the roots, cut hay into chaff, mix the food, etc., besides handling the milk after it is taken from the cows. As a matter of fact, one man can attend properly to only about a dozen cows, and as he has also no difficulty in milking these night and morning, unless the machine is going to do very great work indeed, there is no benefit to be derived.

The daily cleaning of the apparatus is alone a very serious piece of work, for unless this is done the milk may be easily tainted, more than if milked by hand into an open pail.

VI.—Feed and Litter Carrier

On many well equipped farms where a great many cattle have to be fed and attended to—as in the case of a byre full of cows—a light railway is sometimes laid along the floors of the stock shed, on which run small trollies. These serve to convey the food to the animals, and dung trollies also run to clear away the manure. A more recent and better idea has been imported from the United States. This is an adaptation of the overhead wire or monorail system. (See Fig. 13.) Under the rafters behind the cattle a rib of iron on edge is fixed with suitable brackets to form a rail, and on this a trolly hangs with wheels and framework, enabling it to be raised or lowered, or run along. The food from the mixing house, or litter for the stalls, can be brought in, while, most important of all, the dung can be loaded up and run out any distance to the dunghill or tipped into a cart. In place of the rail a wire rope may be substituted, tightly held in position by a large straining post, and "junctions" are easily arranged, whereby the trollies go round corners or change on to another rail.

The great point in favour of the use of this system is that it is much more convenient and inexpensive than a double rail embedded in the floor, while it can be run over a dunghill where rails could not be laid. The trollies are easily pushed by hand, and can be adjusted to any height from the ground. Their use is only just known here, but there are scores of makers of them, and thousands in use, across the Atlantic as a great labour-saving arrangement for what is usually dirty, nasty work. Anyone fitting up a cow-shed or feeding stalls for bullocks or any other kind of stock would be well advised to go

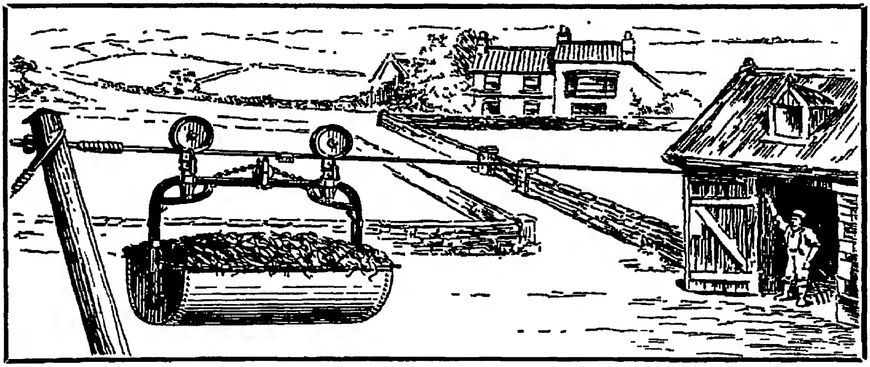

FIG. 13.—STAR LITTER CARRIER.

into the question of arranging their buildings for the use of this form of carrier.

VII.—Sheep Shearer

There has been an increasing difficulty of late years in getting efficient hand shearers to take the wool off sheep, but the invention of a machine for the purpose, driven by either hand or power, has met the difficulty. There are several makes of these on the market now, and most of them are convertible into horse clippers as well, as they are made on the same principle as the latter. In the Colonies the sheep shearing is done on a gigantic scale in many cases, and a power-driven shaft gives motion to a whole row of machines down a shed, but in this country, where the ordinary farmer owns only a few hundreds of sheep at most, the ordinary hand-driven machine is amply sufficient.

The minimum number of men required is two, but a gang of three—two men and a lad to drive the wheel—is the most suitable for getting over the work. While one man is actually shearing and the lad turning the handle the second man is rolling up the fleece he has just taken off a sheep, catching another one, and "opening up" the throat and breast with the common hand shears in preparation for the shearer, at which he takes turn about. By this means no time is lost, and the machine can be kept at work steadily without waiting.

The points in favour of the use of a shearing machine are that it will do some 20 to 25 per cent. more work in a given time than is done by hand; that more wool is taken off and more evenly than by hand; that there is no danger of cutting the skin if ordinary care is taken; and, lastly, that an unskilled man can very soon learn to use it.

The keeping of the tension of the blades correct is the main thing necessary for efficient cutting of the wool, as they want careful adjustment, while, of course, they must be sharp. Ordinarily the speed is 2,000 revolutions, equal to 4,000 cuts, per minute of the clippers, but this, of course, depends partly on the rate of driving.

CHAPTER XII.—FARM MOTORS

MANY of the implements and a great deal of the machinery we have been considering require motive-powers to drive them, and in this chapter it is proposed to review very shortly the applicability of the different forms to farm work.

The ordinary prime-movers used on the farm are the horse, wind, water, steam, and oil; "suction" gas and electricity will probably come more largely in the future, but up to the present these have only been applied in rare instances, though ploughing was actually the first work ever done by electricity (at Sermaize in France, in 1879).

I.—Horse-power

A horse-power to the engineer is a very definite formula, originally fixed by Watt, who, however, made an error in his calculations, so that his figures are much higher than are usually attained by even the largest horses. The standard "horse-power" by which all motors are measured is the amount of force necessary to raise 33,000 lb. one foot high in one minute; the number of pounds raised in the same way by horses are as follows:

Large Horse, walking 2½ miles per hour	26,000 lb.
Ordinary Farm Horse, walking 2½ miles per hour	22,000 lb.
Horse in plough at 1½ miles per hour	22,000 lb.
Light Horse (1,200 lb.) in general work	20,000 lb.
Pony (1,000 lb.) in general work	17,000 lb.

The ordinary average farm work-horse, therefore, is not more than two-thirds as efficient as Watt's one-horse-power.

The actual draught exerted by horses in hauling our various implements is an interesting and useful item of information, and some of the average figures are as follows—per horse.

Loaded Cart per ton	on hard road	70 lb
,, ,,	on farm road	150 lb
,, ,,	on soft grass	300 lb
Binder		170 lb.
Plough		220 lb.

The above table means that if a spring balance (or dynamometer) were hitched in between a horse and the implement it is pulling, the pointer would indicate an average draught similar to the above figures. In ordinary work a heavy horse will do best exerting a draught up to about a hundred weight and a half (say 170 lb.), walking at the rate of two and a half miles per hour, and working for eight hours daily. In other words a horse can pull one-tenth of his weight at regular work and keep it up all day, though for short periods he can exert a power equal to half his weight.

It is noticeable that the heaviest horse can exert the greatest power. Muscular development is very important, of course, but much of the tractive power depends on the animal throwing its body forward so as to shift his centre of gravity on to his forelegs, and thus enable him to "grip" the ground better. A heavy lift—such as pulling a cart out of a hole—is actually made easier to him by a man or two getting astride on his back to hold him down as it were, while his power is for the same reason increased by keeping the bearing-reins very loose so that he can throw himself forward.

The use of a spiral spring in the line of draught—either at the shoulder-hooks or behind the whipple-trees—adds very much to the comfort and efficiency of the horse as a prime-mover; it eases jolts and steadies the draught very much. A liberal use of oats, however, adds most to the tractive power of the animal.

In driving fixed machinery by horse-power, two kinds of gear are used: that in which the horse pulls at the end of a long arm or lever round a centre, as in the ordinary circular horse-gear, and the "tread" power—a revolving platform set on a slope on which the horse simply walks in treadmill fashion, and thus drives it by his weight alone. The latter is the most effective form of utilising a horse's power, but it is very little used in this country, though much in vogue abroad.

II.—Wind-power

The windmill has always been in use in many districts for milling and pumping purposes, and is even yet a feature of the landscape in some places. In recent years, however, there has been a great development in the use of the small steel wheel "wind-engine" for many purposes about the farm such as pumping, grinding, chaff-cutting, etc.

The drawbacks to wind-power are its variability, the comparative expense of erecting a tower, and the fact that it can never develop a

large horse-power with the ordinary size of wheel. The actual power varies with the wind, but with a velocity of 15 miles per hour the old-fashioned cross-sail windmill (60 feet across) develops only about 4½ horse-power. On the same wind velocity a ~~galvanised~~ steel wheel of 16 feet diameter develops about one horse-power, and it can therefore be seen that the power of this kind of ~~motor is very~~ limited outside of its variableness, although wheels on this principle are made up to 40 feet diameter which show up to 12 horse-power in a 25-mile wind.

A windmill must be on a high tower to catch the wind, and some 30 feet above trees and houses, unless it happens to be set on a hill or in an open plain. It must be built to work at a maximum wind velocity of 40 miles per hour : above that it would require to be shut off for safety, while it should be self-regulating below that velocity.

Windmills serve their purpose best when used for pumping water, where there is a storage cistern sufficient to hold a supply over a period of calm. Next to this, grinding meal can be done fairly well because it is easy to arrange a huge hopper over the grist-mill to keep it going, so that the grinding can go on fast or slow, night or day, according to the wind. Chaff-cutting can also be done when advantage is taken of a brisk wind, but as the power given off is comparatively so small with ordinary-sized wheels, both the grist-mill and chaff-cutter must be of small size.

The great point in favour of a windmill is the cheap cost of running, but in these days of small oil- and petrol-engines of great handiness and adaptability, it is doubtful if it is advisable to set up a windmill at all except for pumping water up into a cistern. It would be entirely unsuitable for root-pulping, cream-separating, or any other work which must be done daily at certain hours, and at the same time it is confined to one spot, and is not movable from point to point.

III.—Water-power

In high districts or on farms adjacent to high ground there is no better power for driving the fixed machinery of the homestead than a head of water. It is usually necessary to make a dam to hold a supply, even where there is a running stream, because it may dry up or become reduced in hot weather, but once this has been made and the channel or pipe laid which carries the water to the homestead there is no further outlay. The motor may be either a turbine for great heads of water, or a water-wheel for

anything under 20 feet. The water-wheel, again, may be overshot, breast, or undershot—also according to the head of water—the first being the best because of the greater height utilised. The turbine is the best motor of all because it utilises 80 per cent. of the full power of the water, while the very best overshot wheel is under 70. Against this there is the expense of the heavy iron piping required for a turbine as compared with the embankment and "mill race" of a water-wheel. The wheel, however, and buildings connected with it, are comparatively expensive, so that it depends very much on the distance the water has to be carried in a pipe whether a turbine or wheel is used—the former for preference. Formerly, as pointed out on page 3, homesteads were fixed on a site to suit the use of water-power, but this would not be done nowadays, and where a farm is not already provided with water-power—or where it is not exceptionally easy to get—it is a debatable point if an oil-engine would not be very much better.

Wheels are seldom made over 20 feet in diameter—usually less. The power depends on the head of water and the amount discharged per second, but the usual run of water-wheels at farms is from 4 to 10 horse-power.

Water-power has hitherto been almost solely used for driving the fixed form of thrashing machine, and in these days when "portable" power is desired it is seldom that a new wheel or even a turbine is erected.

Where water-power is running to waste there will probably be a future utilisation for the development of electrical power. A wheel or turbine can now be placed at a minimum cost for pipes or sluices at the side of the water to drive a dynamo, and the power be then carried on wires to any reasonable distance as a motor for machinery. There is a tendency to follow this line now for manufacturing purposes, and there are many farms where this plan could be adopted, where formerly the water was too far away from the homestead or too low down for use.

IV.—Steam power

The use of the steam-engine about a farm depends on many circumstances. Where there is already an engine fixed, no one would think of displacing it for any other motive-power, but when it is a question of erecting a new one, many things have to be taken into consideration.

At many farms steam and hot water are used daily in large quantities for steaming, cooking, and other purposes, and if it is necessary to have a boiler to obtain these, it is manifest that an engine can be conveniently attached to get motive-power as well. This is specially the case with dairy farms where hot mashes are served to the cows, and dairy utensils require to be washed and steamed.

With such conditions a steam-engine and boiler will probably be the best to have. Under all other circumstances, however, and for portable work, steam is giving way to oil.

Several guiding rules should be followed in the erection of an engine. A comparatively large boiler should be adopted in proportion to the horse-power of the engine, not merely to allow of a margin for engine-driving, but for steaming purposes as well. Further, a large boiler can be fired up to a low steam pressure, and kept going with "slack" or any kind of cheap coal dross, instead of the good "steam" coal required for engine running. For this dual purpose again, boilers with little water capacity, and too many flues for quick steam raising are not desirable : this would suit an engine, but more water is required where the steam is used for steaming.

Again, good water is necessary for an engine : if it is "hard," then the lime deposited by the evaporation accumulates, so that the tubes and fire-box become furred up and the boiler is spoiled.

Portable, traction, and ploughing steam-engines are in universal use, but their supremacy is being challenged, and a would-be purchaser would be wise to study the question of coal versus oil before investing. Where coal is cheap and steam is required for other things, then a steam-engine is best for fixed work ; in most other cases oil or petrol would be better.

The application of steam to field work never met with the success that was expected at one time. Our fields are too small for huge engines to work economically, while such work as ordinary ploughing, harrowing, drilling, etc., was found to be better and more cheaply done by horses. The cultivator has been almost the only steam implement retained in our fields, and even this has been very inefficiently handled as aforementioned, and is not likely to be developed any further now.

V.—Oil-power

The tremendous evolution of oil- and latterly of petrol-engines is a sign of the times, and it is not an exaggeration to say that this

form of motive-power is gradually ousting all the others, and is even threatening the supremacy of the horse himself on the farm. Indeed, not many now would think of employing any of the other powers where a new one has to be procured, unless there was some special reason for doing so. For one thing, an oil-engine does not require any boiler, and a little oil and water take the place of loads of coal and tanks full of water for steam. Hence an oil-engine is thus exceedingly handy and exceptionally portable, while it can be started in a few minutes at any time—a point that appeals much to a man who has been accustomed to an engine taking an hour to get up steam.

The drawback to some oil-engines is the necessity for using a "blow-lamp" for starting and vaporising the oil. This is a decided disadvantage where there is inflammable material near, such as straw, and therefore oil is giving way to petrol for small engines, though it is too expensive for large ones. Petrol is the spirit distilled from petroleum, gasoline being the American name for a similar spirit, and these vaporise at ordinary temperatures or at the ordinary heat of the engine parts, and thus require no lamp or vaporiser at all.

We have now, however, a combination of petrol and oil in one engine: a start is made with petrol, without any lamp, and when once the engine is running the heat of the explosions, by suitable arrangements, is sufficient to vaporise petroleum, which is then turned on and takes the place of the petrol. When vaporised it is sufficient to have a storage or magnetic battery (the latter being preferable) to produce a small electric spark to ignite the vapour in the cylinder, and this vapour is sucked in at each stroke. Petrol vaporises at a temperature of 74° Fahr., whereas the ordinary petroleum oils run from 81° (Russolene) to 105° (American White Rose), so engines are now fitted to vaporise the latter without any lamp, and by the heat generated by working only. The use of alcohol or other "spirit" for engine-driving is likely to become common in the near future.

As the successive explosions generate heat the cylinder would soon become too hot, and therefore it is jacketed and a current of water kept circulating, though in the latest forms the circulation is done away with and the jacket is merely kept full of water as it boils off. It has been suggested that where an engine is in use every day this would be a convenient source from which to obtain hot water if not wanted in large quantities.

One-sixth of a gallon per hour, per horse-power (roughly, one pint), is a common allowance of oil to drive an engine, but it varies

according to the size of the engine and the quality of oil, and some petrol-engines have got down to nearly half a pint per hour.

It is a good plan to get an engine of greater capacity than is assumed to be needed. In the case of a steam-engine, by firing up and raising the pressure of steam, it will develop a much greater "actual" horse-power than its "nominal" ordinary running one; but in the case of an oil-engine, if the work is too much for it the engine will stop, and therefore allowance must be made for this drawback in selecting the size for the work to be done.

Conclusion

There is not the slightest doubt that in the modernisation of the equipments of the farm lies great possibilities of development in

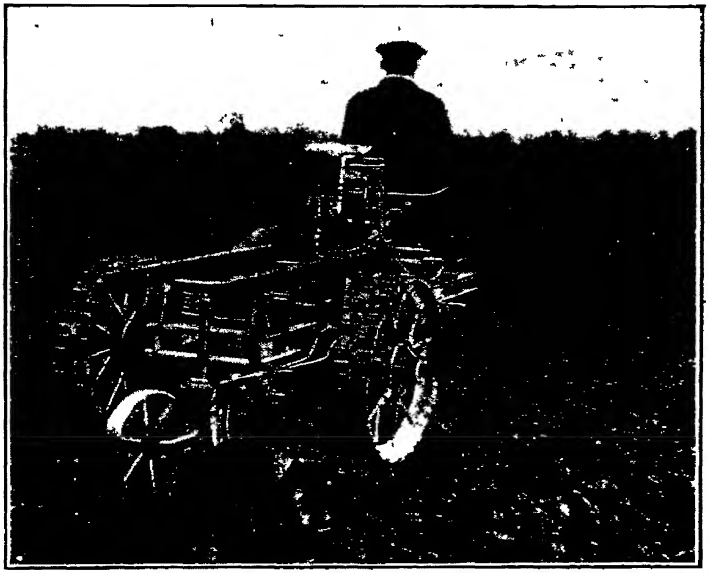

FIG. 14.—SINGLE-FURROW MOTOR PLOUGH AT WORK.

the work of the future. We have still a long way to go before we reach perfection in any branch, but we have hitherto done most with our live stock and our cropping, and there is now greater room for improvement in connection with the fittings and the machinery with which the work of the farm is carried on. The development

of the oil- or petrol-engine as a motive-power is placing great possibilities within our reach that were never thought of or which failed in connection with steam. The price at which oil or petrol-engines are offered is a great inducement in their favour: £8 per horse-power for the fixed, and £12 for the portable forms, brings them within reach of ordinary farm work. The illustration (Fig. 14) shows what has been accomplished already in reducing this power down to the smallest limits in pulling one plough, with corresponding developments in regard to other implements, so that for the heavier and bigger jobs of the farm we are likely to see much done in this way in the near future.

Naturally, of course, the best and most important motor on the farm is the horse, and for portable implements and the machinery of the fields he will probably remain so in the future.

The possibilities of ordinary two-horse work are not exhausted yet, however; in fact, there is ample room for great development as the preceding pages testify, so that the lover of a good horse need have no fear of the future, but the next few years will see much improvement all round.

The horse is our oldest prime mover, he is "made" on the spot, he is beloved by all men on the farm, all our implements have been designed for his use, and we can divide up a gang of horses to do separate jobs in a way that cannot be done with an engine. He will remain, therefore, our best friend for a long time to come, but no wise man will shut his eyes to the fact that modern invention is finding out better, quicker, and cheaper ways of doing the heavy work of the farm by engine-power, and will adapt himself accordingly. The next generation will probably see the evolution of "motor" work much beyond anything we have yet attained to by horse-power, and the farming of the future will gradually reach a pitch of perfection that, as yet, we can only begin to realise and foresee.

During the last generation we have progressed further than our forerunners did in all the centuries before, and in the time to come improvement will be in an ever increasing ratio.

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